Arteries

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SURGICAL ANATOMY OF THE ARTERIES.

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PREFACE

TO THE SECOND EDITION.

The early sale of the first edition of this work, imperfect as it was, being a flattering testimonial of public approbation, my publishers have requested the preparation of a second edition, which I here offer to the medical profession.

Two new and valuable plates are added. The surgical observations are also illustrated by numerous wood engravings. A considerable portion of the first section of the work has been entirely re-written, and numerous additions have been made to the surgical remarks.

TO

MY DISTINGUISHED FRIEND AND FORMER COLLEAGUE,

JOHN EBERLE, M.D.

PROFESSOR OF MEDICINE IN THE MEDICAL COLLEGE OF CINCINNATI,

I inscribe this Work, which is more honoured by his name, than is he by the dedication.

NATHAN R. SMITH.

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SURGICAL ANATOMY OF THE ARTERIES.

PART I.

GENERAL OBSERVATIONS

ON THE

ANATOMY, PHYSIOLOGY AND PATHOLOGY OF THE ARTERIES.

SECTION I.

ARRANGEMENT AND ORGANIZATION OF THE ARTERIES.

The Arteries are those sanguiducts which are prolonged from the ventricles of the heart. They receive the circulating fluid by the impulse of that organ, and convey it to the extremes of the systemic and the pulmonic circulations. The former of these arterial systems, (the only one with which we are to be occupied,) in the form and arrangement of its parts, resembles a minutely ramified tree, the trunk of which, the great aorta, is implanted upon the left ventricle of the heart. To the eye, the trunk and its branches are perfectly cylindrical, but nice admeasurement detects a slight increase of diameter in those branches which traverse some distance without subdividing. As they divide and subdivide, however, the arteries constantly diminish in diameter; but not in the ratio of their divisions; for the united capacity of the branches is every where found to be greater than that of the parent trunk. As a whole, then, the arterial system is a cone, the base of which is in the capillaries, the truncated summit being the root of the aorta.

In tracing the arterial branches to the capillaries, we find that, in their whole course, they make but twenty-one divisions, when they terminate, 1st, in filaments which inosculate with each other; 2d, in exhalant extremities; 3d, by continuity with the radicles of the veins, and 4th, in the excretory vessels of glandular organs. Those branches which spring from the arterial trunk near its origin, generally leave it nearly at right angles, but the more remote divisions are at an acute angle which opens towards the capillaries, and which, for the most part, becomes more acute as the branches recede from the heart. With a few exceptions, the great arterial trunks pursue a straight course; the small branches, however, are very tortuous—even more so than those of the veins.

Besides the extreme inosculations which we have mentioned, there occur frequent anastomoses of considerable arterial branches. These are of great importance in a surgical point of view. They exist especially wherever there occur occasional impediments to the direct circulation, as about the joints. They

are every where sufficient to maintain the circulation by collateral channels, when the great trunks are obliterated. The arteries are, for the most part, much more deeply seated than are the veins and lymphatics, having no general superficial strata like those vessels, and being far less numerous. With each artery there are generally associated two veins and ten lymphatics.

The walls of the arteries are constituted of three cylindrical tunics. The external tunic is a dense and thick body of cellular tissue. It is composed of plaits, or layers, which may be successively stripped from the organ, and which are themselves composed of filaments closely interwoven with each other. According to some, these threads are ligamentous.* Externally, this coat is gradually lost in the surrounding cellular membrane. Internally, it closely adheres to the middle tunic, but may be made slightly to glide upon it, and can be separated by careful dissection. The inner layers of this coat are the most membranous and dense;—the external are filamentous, loose, and gradually lost in the cellular sheath of the vessel. The vital properties of this tissue are obscure;—its physical qualities are remarkable and important. It is extremely tenacious, extensible and elastic. By virtue of the first of these qualities it resists a degree of violence which easily ruptures the internal coats. A ligature tightly drawn upon an artery readily cuts the internal tunics, but never divides the external, unless it be diseased. By its extensibility it yields to distending force which ruptures the internal tunics, and evades the violence which would otherwise destroy it. When an artery is forcibly injected with a fluid, the inner tunics first give way, while the other for a time still resists, and is expanded into something like an aneurismal sac. By its elasticity it contributes to the more perfect exercise of that quality in the middle coat. It is so identified with the internal coats in its connections, in its functions, and in its morbid changes, that we cannot, with Haller, refuse to recognize it as an arterial tunic. This tunic varies in relative thickness in different regions. In the aorta it is voluminous and composed of distinct layers. In the arteries of the brain it is so thin that its existence in them has by some been denied; hence, their occasional ruptures. In those distributed to the abdominal viscera, both this and the external tunic, are comparatively so thin and weak that these vessels are much more frequently the seat of aneurism than those of equal size in other regions.

The middle coat, however, is the peculiar arterial tissue. It is a dense, thick, yellowish red, elastic substance, analogous, in some degree, to the yellow elastic tissue found in certain ligaments of the vertebræ, and in the trachea. This tunic is obviously composed of flattened fibres, wrapped spirally around the artery, but not completely encircling it. They cross each other in various directions, and are arranged in successive layers which may be peeled asunder. It is scarcely possible, however, to separate a distinct fibre or fasciculus throughout its whole length. According to some these principal fibres are united to each other laterally by smaller ones passing obliquely between them. This tissue is far less capable of resisting a rending effort than the external coat, but it is more dense and rigid than it, and hence it maintains the cylindrical form of the organ, even when it is emptied of its blood. Because its principal fibres are arranged nearly transversely, this tunic has more strength to resist a force which distends the artery, than one which elongates it. It is for this reason, in part, also, that a small ligature tightly drawn, cuts this coat with so much facility. The elasticity of this tunic is the most remarkable of its physical qualities. It may be made apparent by dividing an artery, when its extremities will be seen to recede from each other, and its diameter to be diminished;—hence it must be exercised both transversely and longitudinally. It is strikingly manifest in the dead subject, when these organs are stretched or distended by an injected fluid. It would appear, however, from the experiments of Parry, that it is but little exercised in the circulation, except as a passive antagonist to the contractile property of the arteries.

As the arteries subdivide and diminish in size, their tunics become proportionably thicker, stronger, more red, and more irritable. All arteries of the same size are not equally strong. Those of the brain and abdomen are easily ruptured by injection. Those of glands are the strongest.

Every one is familiar with the question which has been so long under discussion, relative to the supposed muscularity of the arteries. Both Haller and Hunter declared the existence of muscular fibres of

* Guthrie on the Arteries.

visible magnitude in the middle coat. Their existence is also confidently inferred by Baglivi, Whytt, Senac, Cullen, Hastings, Parry, Philip, Thompson, &c. The high authority of Bichat, Nysten, Magendie, Berzelius and Young, is arrayed in the negative. The two latter gentlemen, by the nicest analysis, could not even discover the proximate principle of the muscular tissue in the coats of the arteries. This contrariety of opinion has probably arisen from the presumption that vital contractility resides only in the muscular tissue. But, as it is a question yet unsettled, whether any tissue but the muscular is capable of contracting from the action of a stimulus, it is certainly unphilosophical to infer the presence of muscular fibres because the arteries do actively contract upon their contents; and equally so to deny the contractility of the arteries, because muscular fibres cannot be discerned in them. The proper arterial tissue is a peculiar one, and its physical and vital qualities are not to be inferred from analogies, but to be learned by careful observation. It is thus, as I believe, that a degree of vital contractility has been ascertained to reside in the arterial tissue. We shall briefly advert to the argument in speaking of the functions of these organs.

The third, or internal tunic of the arteries, is far the most delicate of the three. It seems designed, not so much to give strength to the arteries, as to finish the interior of these organs with a smooth, polished and lubricated surface, which may occasion the least possible impediment to the transmission of the blood. It is thin, diaphanous, dense, and very brittle. When a ligature is tightly drawn upon an artery, this tunic yields together with the middle coat. When an artery, in situ, is seized and violently pulled, before the external coat will yield, the internal tunic, as I have ascertained by repeated experiments, will be ruptured in many places, and will present numerous transverse fissures. Nevertheless, when the two external tunics have been carefully removed to a small extent from a living artery, the innermost membrane has neither been ruptured nor distended by the current of blood. The surface of this membrane is always bedewed with a fluid resembling serum, which greatly increases its lubricity. This is secreted by the membrane itself. From this circumstance, and from its analogous appearance, this tunic has been, by some, associated with the serous membranes.

When arteries by any cause are made to circulate a greater quantity of blood than usual, they commonly increase not only in their calibre, but in the thickness and strength of their tunics, and in their length—becoming more tortuous. When blood is withheld from an artery, it is gradually contracted to the size of a thread. In old age, the arteries become longer, more tortuous and more brittle.

The arteries are themselves furnished with blood-vessels (vasa vasorum) of obvious magnitude, both arteries and veins, the former of which they derive from their own branches, through the medium of the surrounding cellular tissue. They have nerves, also, derived both from the cerebral and the ganglionic systems. In the neck, chest, and abdomen, filaments of the latter may be traced into the coats of all the principal branches. To this circumstance modern physiologists ascribe great importance in relation to their functions.

The arteries, in most regions, are enveloped in a firm sheath of cellular tissue. This does not greatly differ from the subcutaneous and intermuscular cellular web, except that it is a more firm, tenacious, and less pervious, tissue. It is capable of resisting the sudden effusion of blood into the surrounding parts, when the proper tunics of the artery are ruptured. It is particularly voluminous and extensible in those regions in which much motion takes place, as near the joints. It is strong and aponeurotic where the arteries are but imperfectly protected by other organs. Often, in addition to the cellular sheath of an artery, there is a common envelope which wraps an artery, vein and nerve. Sometimes the latter alone exists, the former not being distinguishable from the external tunic of the artery. In some of the cavities, the larger trunks are destitute of cellular sheaths, and, instead of them, are wrapped in folds of the serous membranes which line those cavities. The cellular sheaths not only protect and support the arteries, but impart vessels and nerves to their coats, and are thus necessary to their nutrition. Hence, in operations upon these vessels, we avoid to denude them, to any considerable extent, of these coverings.

SECTION II.

FUNCTIONS OF THE ARTERIES.

It is by no means my intention to discuss at length the question relative to the vital activity of the arteries in the circulation of the blood. As, however, the subject has a surgical bearing, we cannot altogether overlook it.

The question may be fairly stated in the following interrogatories. Are the arteries merely passive sanguiducts, responding to the action of the heart by virtue of their elasticity alone? or are they endued with a vital contractility, by which they actively aid in the transmission of their contents?

The fibres of the arterial tissue are so short, and the extent of their asserted contraction so limited, that it must obviously be very difficult to ascertain the existence of this property, as we do in other tissues, by ocular inspection; hence the contrariety of testimony on this subject. Mr. Hastings, however, has obtained even this evidence of the existence of the contractility of these vessels, and has ascertained by numerous experiments, that even the larger trunks sensibly contract on the application of those mechanical and chemical stimuli which irritate the other sensitive tissues.* Zimmerman, Lorry, and Verschuir have witnessed the same results from the application of the mineral acids. Strong contractions are also produced by galvanism.

Mr. Parry's experiments, in relation to the arterial pulse, have generally been regarded as supporting the doctrine of the inaction of these tubes. He has, indeed, shown that none of the larger arteries but the thoracic aorta, expand during the systole of the heart, or contract during its diastole; but this result, as it appears to me, should rather prove a corresponding vital effort in the arteries. These organs certainly possess a high degree of elasticity, and may be greatly distended by injected fluids. The heart, at each pulsation, throws the blood into them with great force, and, if they are merely elastic tubes, they should certainly yield and become expanded. The only way in which we can account for their not thus yielding to the impulse of the heart, is to admit a corresponding vital effort on their part, by which they resist the distending force, maintain their calibre, and urge forward the current of blood.†

This must have been Dr. Parry's own view of the subject, as appears from the following extract. "On this principle we may reasonably explain the disposition to excessive hemorrhages, which is so apt to follow violent or long-continued increased impetus in certain parts, or the whole, of the sanguiferous system; such impetus having incapacitated the capillary vessels from that degree of vital *contractility*, which is necessary to the continuance of their healthy functions."‡

It has been shown by Hunter, that the arteries contract more when wounded during life, and also in the moment of death, than they do after death by virtue of their elasticity alone. When he distended an artery which had contracted in the article of death, he found it incapable of recovering its calibre by the action of elasticity.

It is a fact which I believe will be recognized by almost every operating surgeon, that arteries contract and recoil from the irritating touch of instruments. When an artery is first cut across, it pours out a stream of blood equal to its natural calibre; but long before coagulation can result, we often see the stream diminishing, and at length altogether ceasing, although its extremity is completely unobstructed. When, under these circumstances, a ligature is not applied, but the organ is covered by the surrounding parts, and warmth restored, the coats of the artery become again relaxed and secondary bleeding very often results. Two years ago, I extirpated a diseased testis in the presence of the late Professor Davidge and Dr. Wegner, of this city, in which operation I witnessed the following phenomena. There was a rapid gush of blood when the cord was divided, but, before I was ready to use the tenaculum, it had very much diminished. After

*Introduction to Treatise on the Mucous Membranes.

†Experimental Inquiry into the Nature, Causes, and Varieties of the Arterial Pulse.

‡Elements of Pathology and Therapeutics.

securing two or three arteries, I raised on the instrument a small white cord, which I at first supposed to be an artery; but no blood issued from it, and on carefully examining, I did not discern any opening in its extremity. I then supposed it to be a nerve, and desisted from the application of the thread. An hour after the dressings were applied, I was under the disagreeable necessity of removing them to suppress a profuse hemorrhage. On opening the wound, and turning out the coagula, I discovered the bleeding vessel to be the white cord which I had before noticed. It was now bounding, and emitting a rapid stream of blood.

These occurrences are not to be accounted for by supposed vicissitudes in the action of the heart; for they are noticed in trivial operations which rather stimulate the general circulatory system, as well as in more formidable injuries which prostrate its powers.

Some years ago, I had occasion to apply a ligature to the anterior tibial artery, that organ having been wounded by a narrow cutting instrument, below the middle of the left leg. I was assisted by Dr. Jamin Hamilton, who, with myself, noticed the following facts. The ligature having been applied above the wound, the bleeding immediately ceased. At the end of a few hours, however, it returned, and the blood evidently flowed, in the retrograde direction, from the inferior portion of the wounded artery. On applying the finger to the anterior tibial artery, on the tarsus, it was found actively beating. Presuming that the course of the blood was recurrent, I applied one finger upon the artery, just where it merges itself between the metatarsal bones—another higher up, on the tarsus. When I pressed firmly with the lower finger, no pulsation was felt by the other, but when I pressed with the upper, the artery still beat below. Although this artery received no blood but through anastomosing branches, and consequently was greatly protected from the vis-a-tergo of the heart, yet it beat with far more force than the corresponding artery in the other foot. It should be remarked that the left leg, near the wound, was under high inflammatory excitement. The increased action of the artery, then, must have been owing, not to the impulse of the blood from the heart, but to the vis-insita of its own coats, and of the capillary vessels communicating with it. It is in vain to say that the blood, finding its way into the artery by the anastomosing branches, was unable to escape freely in consequence of the obstructions at the wound, and thus distended the artery. The artery seemed to empty itself freely between the beats, and could then be scarcely felt; besides, blood, it is known, will not so freely seek vessels which are thus obstructed.

The morbid variations of the arterial pulse, every day noticed in the practice of medicine, appear to be altogether inexplicable, on the supposition that the throb of the artery is entirely owing to the impulse which the circulating blood receives from the heart. Even those who are not over-nice in their distinctions, recognize many varieties of the pulse, necessary to be observed in careful diagnosis. The strong and full pulse, the frequent pulse, the quick pulse, the weak pulse, the intermitting pulse, the undulating pulse, may each depend upon the peculiar action of the heart, as it varies in force, quickness, or regularity. But how can any peculiarity of action in the heart produce the small, corded, wiry pulse; or the soft, dilated pulse, both of which may exist with the same power of action in the heart? If the arteries are merely elastic tubes, these variations should never occur but from the action of those chronic causes which impair the texture and physical qualities of the arteries. But they are observed to result from sudden affections, which can only influence the coats of the arteries through the medium of the nerves. It is vital contractility alone which can be thus influenced.

In animals, and in fœtal monsters, which possess no heart, the circulation is carried on by the action of the arteries alone. In certain cold-blooded animals, even for hours after the heart has been removed, we see not only the motion of the blood, but the contraction and expansion of the arteries by which it is effected.

The pulse of arteries is not always uniform in all parts of the system; it has, as we have seen, a peculiar force in inflamed parts, and is feeble in a paralized limb. The pulse is sometimes more frequent in one wrist than in the other.

The evidences to which we appeal, in proof of the exercise of an active vital property in the *capillary* vessels, are still more numerous and striking than those which we have adduced in relation to the functions

of the larger branches. The phenomenon of blushing is a fact which it seems impossible to evade. An emotion of the mind occurs, and, from the sensorium, an influence is transmitted to the small vessels of a portion of the skin. This vital impulse can have no control over the physical elasticity of these vessels—it can only influence them vitally, and must operate on a vital quality resident there, and which responds to the stimulus imparted. Even those who maintain that this prompt determination of blood to a part is owing to a sudden reduction of vital power, and a consequent yielding of the vessels to the vis-a-tergo of the heart, admit all for which we are at this moment contending. For if there occurs such a thing as relaxation, or debility of these vessels from variations of nervous influence, it must be the debility of a contractile tissue; for an elastic membrane cannot thus suddenly lose its physical quality.

But I will go further, and endeavour to show that the capillary vessels, in becoming surcharged with blood, do not always merely become relaxed, but often take to themselves an unusual supply of blood by their own independent action. If this be made manifest, then will it follow that they must exercise an active influence over the ordinary circulation of the blood.

Whenever a substance, which is known to be a powerful stimulus, is applied to any vascular portion of the healthy skin, an increased flow of blood to the part immediately results, as is obvious from its increased volume and redness. This is the invariable action of alcohol and ether on the skin, when so applied as to prevent evaporation. Now, the heart sends the blood to every other part of the integuments with the same force as to this, consequently the increased flow to it must be owing to a change of action in its vessels, and this change can be nothing else than an increase of excitement; for the substance applied can thus influence nothing but vital qualities, and these, as we know from observation, it always stimulates.

There are certain highly vascular tissues in the human body, termed erectile, in which remarkable fluctuations of the circulating fluid are observed to take place. These are the male penis, and the nipple and clitoris of the female. Whenever excitement is produced in these organs, although the action of the heart remains uniform, they immediately become engorged with blood. This certainly must be something more than the mere yielding of vessels to the vis-a-tergo of the heart. The turgescence of the organ is accompanied with manifest excitement of the nerves, and consequently with increased energy of every contractile fibre. The capillaries of these tissues must, then, exercise a power by which they, as it were, pump the blood from the larger arteries with increased rapidity.

Those morbid congeries of vessels, denominated aneurisms-by-anastomosis, furnish facts in support of the same position. When the surgeon, in extirpating these tumours, cuts widely around their bases, incising only the healthy parts, there is but little more bleeding than in the extirpation of ordinary sarcoma; but if he incautiously wounds the bundle of diseased vessels, there occurs a furious gush of blood, extremely difficult to control. It would seem, then, that these vessels have the power of soliciting forward the current of blood, through the nutrient arteries of the tumour, much faster than it is driven by the mere impulse of the heart.

Did the limits of our work permit, we might adduce, in support of our supposition, other facts derived both from human and comparative physiology, but the above will perhaps suffice for our present purpose. To all those facts, however, which seem to prove that the capillaries are capable of actively imbibing blood from the arteries, Vacca, Phillip, Allen, Hastings, and others, oppose the specious dogma that no living tissue can expand or become elongated by any vital effort, but only by passively yielding. They assure us that no muscular fibre is seen to exercise power but by contraction, and that, if the coats of the arteries contain contractile fibres, their action can have no other influence than to constrict the vessel and diminish its calibre. There is certainly a difficulty here in the *quo modo*, which is not easily overcome; but I am not aware that when we have rendered a fact manifest to the senses, we are compelled by any rule of logic to reconcile it with preconceived opinions. We have shown that when the capillaries are excited they fill themselves with blood by acting independently of the heart. There is no more propriety in denying this, because it cannot be explained, than there would be in denying the function of the absorbents, because the mechanism of their action cannot be discerned. Let those who deny the power of the capillaries explain

the action of the absorbents in drinking up two or three gallons of water from the abdomen in a few hours. Who will deny that they do this by a vital action which must increase their capacity? But if the absorbents can take up a fluid thus thrown completely out of the circulation, is it not absurd to deny the power of the capillaries to *absorb* a fluid from larger vessels with which they are directly continuous, because the modus-operandi cannot be explained?

Mr. Hunter did not hesitate to declare, that in effecting local determinations of blood, the vessels concerned actively dilate. This is a doctrine which has been generally condemned as absurd, but reflection has convinced me that it is at least a rational hypothesis. We are accustomed to see the contractile organs act merely by increasing their diameter and diminishing their length. But the arterial tissue is organized in a very different manner; and why may we not suppose that this laminated body acts by diminishing its thickness and increasing its expansion?

The doctrine of the active expansibility of the capillaries, in the circulation of the blood, was taught for many years by the late Professor Smith, of Yale College. It has been recently very ably advocated in an Essay by Dr. Hodge,* of Philadelphia, and, as I learn from his pamphlet, has also been taught by Professor Schultz, of Berlin.† For many interesting facts, in relation to the subject, I refer the reader to Dr. Hodge's Essay, and to Professor Smith's paper in the Philadelphia Monthly Journal.‡

The facts and reasoning which we have stated above will justify the inference, that the more active agents of the circulation are at the two extremes of the arterial system—the heart at one extremity, and the capillaries at the other; that the common trunk of the arteries co-operates in the circulation by the re-action of its elasticity; that the minor arteries exercise an obscure contractility; and that the capillary vessels exercise a degree of motive power, by which they not only urge the blood along their own tubes and into the veins, but, by a kind of suction, derive it from the larger arteries and hurry its current along these vessels.

A recent writer, Mr. Rogerson, of Liverpool, in a treatise on inflammations, ascribes an important agency in the circulation of the blood to a motive power resident in that fluid itself. The idea was suggested by Hunter, and has been of late a favourite hypothesis with German physiologists. It would appear, however, that there is in this an obvious absurdity; for how can a fluid possess motive power, when its very property of fluidity implies its inability to modify its form, or change its place?

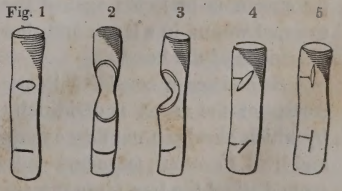
SECTION III.

PATHOLOGY OF THE ARTERIES.

Wounds and Injuries of Arteries.

Immediate effects of Wounds of the Tunics.—The physical and vital qualities of the arteries already noticed, are exercised in an interesting manner in the wounds and injuries of those organs. On wounding the arteries of living animals with a cutting instrument, M. Cloquet arrived at the results illustrated in the accompanying cuts.

When the coats of an artery are divided transversely, to the extent of one-fourth of its circumference, the wounded membranes retract in the direction of the length of the artery, to such an extent as to produce an elliptical opening, the transverse diameter of which is equal to more than half of the length of the wound. (fig. 1.) When the division includes three-fourths of the circumference of the vessel, the retraction is very remarkable, the lips of the cut receding to an extent nearly twice



* Essay on Expansibility as a Vital Property. † Meckel's Archives of Anatomy, for 1826.

‡ Philadelphia Monthly Journal of Medicine and Surgery, November and December numbers, for 1829.

as great as the length of the cut, and, both above and below, the artery presents the appearance of a writing quill, cut obliquely as for making a pen. (fig. 2. & 3.) When an oblique incision is made, to the extent of one-fourth of the circumference of the vessel, the appearance of the wound is such as is represented in fig. 4, the retraction being less than in fig 1. When a cut of the same extent is made in the longitudinal direction, the retraction is very slight, and the appearance of the wound is seen in fig. 5.

The greater expansion of a transverse wound is not because the tunics in the longitudinal direction exercise a greater degree of elasticity, but because the elasticity of a greater extent of these tissues act upon the wound, the tension of the vessel perhaps an inch from the wound assisting to open it. When the cut is longitudinal, only a small extent of tissue, equal to the circumference of the vessel, can exercise its elasticity, and this is in a degree antagonized by the longitudinal tension of the vessel.

When an artery is completely divided transversely, it usually retracts and conceals its divided extremity within its sheath. In regard to this, however, different arteries vary exceedingly. Arteries which traverse bony canals do not retract at all; nor do they in any appreciable degree, where they are bound to the surface of a bone by the periosteum. Where arteries permeate firm tissues, which are themselves not liable to much extension or contraction, such as the scalp, the gums, &c. these vessels retract but slightly, when divided. They contract to greatest extent where lodged in loose tissues, and in parts subject to much motion, as the axilla, &c. The extent of retraction may be influenced by the existence, near the place of section, of branches, which must obviously check it. When both artery and sheath are completely severed, the artery will not recede so far into the sheath, because this also retracts and, to some extent, follows the vessel.

An artery also *con*tracts when divided, and has its canal diminished. This is because its transverse elasticity is no longer fully antagonized by the distension caused by the strong current of the blood, and because its walls are thickened by retraction. But this effect is sometimes more remarkable than would result from these causes, the canal of the vessel being for a time completely closed; and then, undoubtedly, vital contractility is exercised. The peculiar effects of lacerated wounds in arteries we shall notice under another head.

Hemorrhage from Wounded Arteries.—When an artery of appreciable magnitude has been wounded, there issues from the orifice of the vessel a rapid jet of blood, exhibiting a vermilion tint, and usually flowing per saltum, the leaps in the current corresponding to the systole of the heart and the pulse of the artery. The flow continues, however, between the beats, though less rapid. If the artery be merely wounded laterally, and not divided, the pressure of the finger on the vessel below the wound will cause the fluid to issue with more rapidity. But if the vessel be effectually compressed on the side toward the heart, blood ceases to flow from the wound, except in those instances in which it issues from the lower portion of the artery, in the retrograde direction. When the wounded vessel near the place of injury has free anastomoses with other arteries, it will often bleed at once from both the upper and the lower portions of the vessel. Usually, however, the primary bleeding is from the upper orifice alone. Mr. Guthrie confidently declares that, when bleeding has once ceased, and is subsequently repeated, (consecutive hemorrhage) it is almost invariably from the inferior portion of the divided vessel. He also avers that it then flows in a uniform, continuous current, and exhibits the hue of venous blood.

The mode in which blood flows from a wounded artery is often varied by circumstances. Sometimes the stream is projected against the walls of the wound, and so broken and checked as to issue from the external wound in a larger and slower current; but it then issues with undulations which correspond to the pulsations of the heart.

Sometimes a considerable artery is wounded by a splinter of bone, there being no lesion of external parts;—or the vessel is divided by a narrow, penetrating instrument, through the oblique wound produced by which blood can not flow externally. Then the parts around the vessel quickly become tumid—mottled and livid in colour, tense and pulsatory, the pulsations corresponding to those of the heart, and being the more distinct the less tense the tumour is. That part of the tumour is most prominent, soft and pulsatory, which corresponds to the wounded portion of the artery. When the hand is there applied, a peculiar thrill,

or jarring rush of the fluid is felt, as it gurgitates over the margins of the wound in the vessel. The tumour thus formed and characterized, is often termed a "false, diffused aneurism."

Sometimes, the wound of the vessel being small, and the tissues around it firm, the effusion is strongly resisted by the adjacent parts, which become slowly distended by it into a distinct cyst, its walls being formed of successive layers of cellular tissue which it assumes as it expands. This is termed "false consecutive aneurism," a subject which in this place we can not with propriety discuss.

Spontaneous cessation of Hemorrhage from Wounded Arteries.—So impetuous is the flow of blood from the wounded arteries of primary magnitude, that, in man, death is usually the speedy consequence of such an injury, unless art promptly co-operates with nature in arresting its effusion. When, however, smaller vessels are interested, although the flow may be for a time rapid and alarming, the effusion will gradually diminish, and finally cease, even although art may furnish no external aid. This interesting result is accomplished by the efforts of nature, or rather is affected by the agency of certain vital and physical qualities resident in the blood itself—in the arterial tunics—and in these tissues generally. By these there is instituted and conducted a process which either restores the integrity of the wounded organ, or closes its orifice and dispenses with its functions. This process is in the highest degree interesting and important. Although seemingly contingent, it is, as we may term it, a function of reserve, absolutely necessary for the continuance of our species, for without it every wound which draws blood would prove fatal. As we might expect, therefore, it is a subject which has often occupied the attention of the surgical pathologist. Happily it is one in which his labours have been attended with the most satisfactory results.

The first who attempted any thing like a philosophical investigation of this subject, with an adequate knowledge of the functions of the arteries, was Petit, in 1732. He came to the conclusion that the means employed by nature for the suppression of hemorrhage from a wounded artery, consisted in the formation of two clots,—one, (which he called the bouchon, or cork,) lodged in the orifice of the wound, and the other (the couvercle) covering it externally. The latter he considered the most important agent. But Petit only regarded this process as successful when but the fourth part of an artery had been divided.

Morand soon after called the attention of surgeons to the agency of contraction and retraction in the tunics of the artery, as aiding to suppress hemorrhage. Pouteau, however, denied the correctness of both Petit's and Morand's positions, and ascribed the suppression of hemorrhage to lateral pressure on the vessel, caused by the swelling of the surrounding cellular tissue. J. Bell adopted the same view.

But there is no department of pathology which has been made the subject of such clear and satisfactory demonstration as that of bleeding arteries, as discussed in the admirable treatise of Dr. Jones on the process employed by nature in suppressing hemorrhage. This gentleman, by a series of experiments conducted in the most satisfactory manner, and so varied as to embrace almost every contingent circumstance, established the following results:

1st. Whenever an artery is divided, there is always an effort apparent on the part of nature to arrest the bleeding, the result of which depends upon the magnitude of the artery, the manner in which the wound is inflicted, and the relations of surrounding parts to the injured organ. Unless the injury be very peculiar, the division of an artery of the magnitude of the femoral, the brachial, the carotid, or larger organ, will be attended with fatal hemorrhage, provided the efforts of nature be not aided by art. Still, those efforts will be made, and evidences of them may be seen after death. When a smaller organ is divided, the result, in many instances, may still be fatal, but more frequently, even without surgical aid, the resources of the sanative principle will suffice to arrest the flow and seal up the orifices of the injured organ. This is effected by several causes conjointly operating. First, the artery both retracts and contracts, in such a manner that its calibre is diminished, and its extremity withdrawn into the cellular sheath. Secondly, by the loss of blood which takes place, the power of the heart is diminished, and the natural rapidity of the circulation restrained. Thirdly, the extremity of the artery having retracted a short distance into its sheath, the blood flows into the canal of the sheath, beyond the artery, and insinuates itself into the loose tissue between the sheath and the artery. In flowing through the canal of the sheath, the surface of which, very

unlike the polished, lubricated surface of the artery, is rough and penetrable, the blood is impeded in its passage, injected into the membrane, and speedily deposites upon it a coat of coagulum. To this, layer after layer attaches itself, till the cavity of the sheath is filled, and a firm barrier is opposed to the vessel. This is termed the external coagulum. The blood which retrocedes between the artery and the sheath, as well as that which flows into the surrounding cellular tissue, coagulates and fortifies the mass at the end of the artery. Fourthly, a barrier being opposed to the escape of blood from the artery, that fluid becomes stagnant at the end of the organ, as far as to the first branch, and deposites a coagulum of a conical form, the base being towards the wound. This coagulum is much smaller than the calibre of the artery, and, according to Dr. Jones' experiments, is never sufficient to close its orifice and obstruct the blood, unless the artery be lacerated, and the internal coat ruptured in many places, when the coagulum will fill the artery and be attached to its walls by lymph effused from the ruptures. Fifthly, the blood being temporarily arrested by the above agents, the powers of life institute a process for more permanent reparation. In the extremity of the wounded artery a degree of excitement takes place, which causes the effusion of lymph, both between the coats of the artery, thus thickening its walls, and within its orifice. This fluid attaches itself to the coagulum, and blends itself with it. This will have taken place to some extent in less than twenty-four hours, and, soon after, the margin of the artery will have become confounded with the surrounding cellular tissue, and the orifice will be sealed up with lymph. At length, by the organization of the lymph and blood within it, and by the contraction of its coats, the cavity of the artery becomes obliterated as high as the first branch; and the organ is at last converted into a dense cord, not to be distinguished from the cellular substance, but by its superior density. While the circulation through the great artery is thus interrupted, the member is receiving through anastomosing branches, a sufficient supply of blood for the preservation of its vitality. But nature soon opens a way for a more adequate supply, by gradually enlarging those branches which arise from the artery above and near the wound, and which communicate with other branches arising from the vessel below: Thus does the trunk below the wound again receive blood and resume its offices. This is termed the "collateral circulation."

The mere puncture, or partial division of the coats of an artery, is a kind of injury which may be attended with more or less mischief than a complete division of the organ. If the wound be slight, nature will effect a complete reparation of the organ, and restore the integrity of its function; but if it be large, and of a particular form, the artery will at length separate by ulceration,* and become obliterated; or will continue to bleed at intervals, from not being effectually obstructed by the coagulum; or, finally, there will be formed a traumatic aneurism.

Dr. Jones has established, by the clearest induction, the doctrine of Haller and Petit, that wounded arteries are capable of self-reparation. He ascertained by numerous experiments, that when the walls of an artery are wounded longitudinally, or, to a small extent obliquely, or transversely to the extent of no more than one-fourth of its circumference, blood will, for a time, flow profusely. But a portion of this fluid necessarily insinuates itself between the artery and its sheath, separating the latter from the former. The cuts through the artery and its sheath are then no longer coincident, and still a larger portion remains in the sheath, because of the remoteness of the wounds. The blood then coagulates, and adheres to the margins of the cut, and being firmly embraced by the sheath, it is steadily opposed, as a strong barrier, to the wound in the organ. The flow of blood is thus resisted, and nature gains time for more effectual reparation, which is accomplished in part by the effusion of lymph from the margins of the wound, sealing up the opening, and in part by the deposition of lymph upon the external surface of the artery, near the wound, and within the sheath. At length, after the lapse of eight or nine days, this becomes organized—cicatrization takes place, and perfect reparation is effected.

From the experiments of Jones, Beclard, and Cloquet, it appears that, in dogs, horses, and other animals, an artery is capable of self-reparation even when divided through more than half of its circumference, provided it be not at all denuded of its sheath. Such, however, are not the results of similar

* Treatise on the Process employed by Nature in Suppressing Hemorrhage.

wounds inflicted on the vessels of man. In these, inflammation and ulceration are observed much more frequently to occur, and the recuperative effort is less active and less effectual.

When an artery is nearly dissevered, the sides being unequally retracted and the organ irritated, it is sometimes completely separated by its own efforts; or this is effected by ulceration, which wastes its tunics where they are still continuous; and then the recuperative process is the same as when the artery is at once cut across.

When, however, the wound is too extensive for cicatrization, and yet the artery does not spontaneously separate, we have, either long continued, or frequently recurring hemorrhage, which at length exhausts the patient; or we have traumatic aneurism.

The former is apt to be much more difficult of control than when the artery is completely divided, and for the following reasons:—First, the artery cannot retract, and thereby withdraw its bleeding orifice within the canal of its sheath, but the wound in the sheath remaining opposite to that of the artery, the blood flows freely into the intermuscular and subcutaneous tissue. This tissue is far more pervious and extensible than the sheath of the artery; consequently, the extravasated fluid permeates and distends it in every direction. A voluminous coagulum is formed, but it is never so firmly opposed to the bleeding orifice as is the coagulum within the sheath of a divided artery, because this coagulum is not itself, in turn, sustained so firmly. The amount of pressure which is made upon it by the surrounding parts is, indeed, very great, but it is at no point equal to the re-action of the canal of the sheath, in case of division. Every one, therefore, at all acquainted with the principles of hydraulic pressure, must be aware that the effect on the bleeding vessel will be far less. This is illustrated by the direct application, to a bleeding vessel, of the point of the finger, which will thus control it with great ease. But if pledgets of lint compresses, and coagula cover the vessel, the utmost pressure of the whole hand will often avail but little.

2d. When an artery is but partially severed, some portion of blood will still continue to flow along the vessel; consequently, no coagulum can form within the organ, nor can a deposition of lymph so easily take place. Besides, if it be true that the capillary vessels and the arteries themselves, are capable of influencing the current of blood along the vessel, it is obvious that the flow of it must be rendered much more impetuous than when the capillaries are entirely cut off from continuity with their trunk, and will therefore very much interfere with the recuperative process.

However nature may modify her process to suit the peculiarities of the injury, it is manifest that the sudden diminution of the force of the circulation consequent upon the loss of blood necessarily resulting from the wound of a considerable artery, must be highly favourable to the completion of the process which we have described. The coagulation of the blood in man is known to occupy from five to eight minutes of time, and if a large artery be the seat of injury, it is obvious that before the expiration of this period death would invariably result, did the bleeding continue with uniform rapidity. But scarcely does the bleeding commence, before the heart feels the sudden loss;—the current quickly becomes less impetuous, and in one, two, or three minutes, syncope results, and the circulation is suspended. Before it is resumed, which, however, is slowly and feebly effected, coagulation will usually have taken place within the wound; and if not, or if it be not effectual, blood will again flow till syncope is repeated, and a respite is obtained for further efforts on the part of nature. When at length, the hemorrhage ceases, and the circulation is re-established, it remains extremely feeble for hours or days, and the blood is driven with but a faint impulse against the barriers which oppose its effusion. When the natural force of the circulation is restored, organized matter will have taken the place of the coagulum.

Mr. Guthrie, in his recent work on the "Diseases and Injuries of the Arteries," by no means admits all the conclusions of Mr. Jones. He ascribes far less importance, than does this gentleman, to the formation of coagula, either external or internal, and especially the latter, but regards the contraction of the very extremity of the wounded vessel as by far the most efficient of the means employed by nature. He appeals to the admitted fact that, even in the human subject, arteries of considerable magnitude, when divided, will often cease to bleed with their extremities completely exposed to the air, and the whole process obvious to the eye.

This is often seen to happen after an amputation, before all the vessels are secured. Mr. G. has sometimes allowed hemorrhage to continue from the radial or ulnar artery, after amputation at the wrist, until it spontaneously ceased under his eye. He adduces many instances of accidental wounds, in which hemorrhage has spontaneously ceased, under precisely the same circumstances, in arteries of the size of the brachial or tibial. When bleeding has thus ceased, he has clipped the very extremity of the vessel and hemorrhage has instantly recurred. He has found the orifice of the vessel, under the circumstances, much contracted, and capped with a small coagulum which adhered to the cut margin of the artery. He has observed, however, that, after the lapse of a short time, the vessel will have become contracted to the extent of an inch or more above the section, though most so at the orifice. The same distinguished author also adverts to the fact, that the divided arteries in the stump of an amputated limb, as they cease to bleed, invariably cease to pulsate. He also dwells upon the fact that when even a large artery has been divided, if it be seized at its extremity with the finger and thumb, the slightest pressure will arrest the hemorrhage, showing that the force with which the heart sends its blood into the vessel is extremely small. From these facts he would infer that the arteries are themselves actively concerned in the circulation;—that the force with which the blood issues from a divided artery, is, in a great degree, owing to the action of the vessel itself, and that the spontaneous cessation of hemorrhage results partly from the cessation of this action.

We cannot but admit the force of these arguments, and, although the agency of the natural means pointed out by Mr. Jones in most instances of spontaneous cessation of hemorrhage, is sufficiently established, it is obvious that he has ascribed rather too much importance to the retraction of the artery within its sheath, and to the formation of the external coagulum. This gentleman also takes too little into account any vital action of the vessel itself in the continuance of hemorrhage, or the suppression of it. In another section, I shall have occasion to show that the continuance, or repetition, of hemorrhage from a wounded artery, is often owing to the infliction of irritation on the wounded part, and that whenever it takes place, there is evidently an increased action on the parts of the wounded vessels. A case in proof of this assertion I have related on page 13. So far from always witnessing any useful agency on the part of the external coagulum in the suppression of hemorrhage, I have sometimes found a wound bleeding rapidly, although stuffed with a coagulum; and I have often seen the hemorrhage to cease instantly on the wound being opened, the coagula removed, and the vessel exposed to the air; nor under such circumstances does the bleeding usually recur.

In regard to the formation of traumatic, or spurious aneurism, as a consequence of wounds inflicted upon arteries, the most eminent writers—Jones, Bell, Hodgson, Cooper, and others, slightly differ. Dr. Jones, who, in regard to most particulars, is the best of authorities, avers that, during the languor of the circulation which results from the loss of blood, the wound in the artery becomes obstructed with effused lymph; but the powers of the system beginning to re-act, before this can become in any degree organized, or sufficiently incorporated with the artery, the lymph yields to the impulse of the blood, and is slowly dilated into a sack, which is fortified, externally, by the sheath, the coagulum, and the adjacent cellular substance. I have observed, however, that lymph, recently effused, though tenacious, is but little susceptible of dilatation, and I am therefore inclined to believe that traumatic aneurism generally commences more immediately in the sheath, the wound in the artery being such as cannot be closed effectually by lymph, but yet, not opening the sheath so freely as to render easy the escape of blood from it. As the sheath becomes distended by the impulse of the blood, it is strengthened by the deposition of lymph, both internally and externally. Some portion of the surrounding coagulum, also, becomes the matrix of an organized tissue, which is superimposed on the expanding sheath. The opening in the coats of the artery remaining, at each systole of the heart the blood is thrown with a stronger impetus into the cavity. The walls of the aneurism then expand, but presently re-act by their elasticity, and return a portion of blood into the artery, so that the contents of the tumour are slowly changed. Hence, the pulsation and characteristic thrill of the tumour.

Aneurisms, it is true, may sometimes be primarily formed in the cellular tissue which is exterior to the artery; but more generally, when the blood freely escapes from the sheath, it either, unless arrested by art,

escapes with fatal rapidity from the external wound, or diffuses itself widely through the common tissue, coagulating, producing inflammation, undergoing chemical changes, and destroying the cellular membrane and perhaps the organs which it envelopes.

Cause of the Spontaneous Cessation of Hemorrhage from Lacerated Arteries.

It is a well known fact, that when a limb is torn from the body, or when organs involving very large arteries are rudely lacerated by obtuse instruments, hemorrhage will often spontaneously cease, even from vessels which always bleed fatally when smoothly cut. Cheselden's case, in which the arm, with the scapula, was torn from the body, will occur to the reader, and perhaps others of a similar character. Such a case fell under my own observation, some years since, in the state of Vermont. A young man was caught by the arm in the drum wheel of a factory, and the limb, together with the scapula, was rent from the body. I saw the boy a week after the accident, and witnessed the dressing of the stump. I was informed that but a very small quantity of blood had been lost, although no arteries had been secured. No secondary hemorrhage ever took place, and the patient recovered with surprising facility. The case was treated by the intelligent Professor of Surgery in Dartmouth college, Dr. Mussey, who has given an interesting account of the case in the New England Journal of Medicine. Many similar cases are on record.

Mr. Jones paid but little attention to the subject of lacerated arteries, and does not appear to have performed any experiments particularly for the purpose of comparing such injuries with others, in relation to hemorrhage. In one instance, however, he lacerated the carotid of a horse, and the animal bled to death. In another instance, he did the same, but arrested the bleeding by pressure on the artery. He reports that, in these cases, the internal coat was lacerated in many places, and that there were formed internal coagula, large enough to fill the artery, and that they were attached to it by lymph effused from the fractures in the internal coat. Although he seems to think the internal coagulum a more perfect barrier in this case, yet he does not appear to have ascertained its comparative influence in suppressing hemorrhage; indeed, he says that "the natural means of suppressing hemorrhage, the peculiar state of the coagulum excepted, were the same in these cases of lacerated arteries, as in ordinary wounds of arteries; but I am not solicitous of pressing this opinion."

The opinions which have been stated by various surgeons, relative to the spontaneous cessation of hemorrhage from lacerated arteries, are exceedingly vague and contradictory. From this we may infer that the subject has not been thoroughly investigated by experiment. M. Richerand* states, that large arteries, when ruptured, become closed, (*se reserrent*) partly in consequence of the chill which they suffer, producing spasm, and partly by the pressure which the muscles, within which they retract, exercise upon them. M. Delpech† states, that when a limb has been torn from the body, the principal artery is sometimes broken within the parts of the stump which have resisted the violence, so as to hang, out at the wound, and sometimes within the lacerated limb. In neither case, he says, is hemorrhage apt to take place. He has so much confidence in the security of the vessels, that he advises not to seek for them in treating lacerated wounds unless they bleed. Sir Charles Bell says, "A torn artery does not bleed. I have heard it affirmed that, in this case, the blood was stopped by the rugged portions of the inner coat of the vessel, which is torn into shreds by the violent elongation of it. It has been said, if we disclose the radial artery of a dead body, and, putting a probe under it, tear it forcibly, the inner coat will present an appearance of valves to intercept the flow of blood. I believed in this statement, but, upon the experiment being repeated, I found that in a young and healthy artery the change could not be exhibited." Professor Gibson‡ asserts that, the indisposition manifested by a lacerated part to bleed, is owing to the injury sustained by the nerves, not only in the immediate vicinity of the wound, but to a greater extent around than the eye can discover. Hence, the

* Nosographie Chirurgicale, tome 1, p. 170.

† Precis des Maladies Chirurgicales. Par J. Delpech, tome 1, p. 138.

‡ Gibson's Surgery, vol. 1, p. 92.

arteries are paralized, and do not contract to propel the blood which coagulates in their cavities, or among the torn muscular fibres.

It is apparent, therefore, that the mode in which hemorrhage from lacerated arteries is arrested, is by no means an established principle in surgery. For the purpose of furnishing facts which may aid to render it such, the following experiments were instituted.

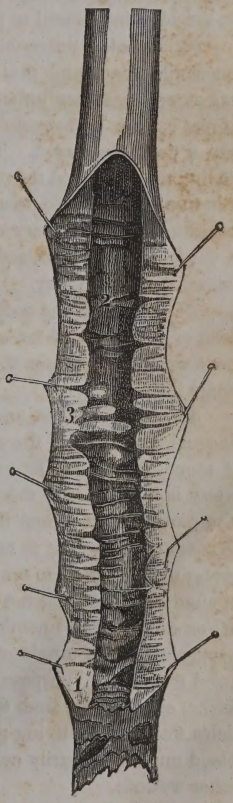
Exper. 1. Having exposed the femoral artery of a young slut, not fully grown, I passed a smooth iron hook under it, and lacerated the organ by a sudden pull. Blood immediately gushed from it in a rapid stream, and continued to flow copiously for about four minutes. At the end of that time, the blood on the table began to coagulate, and, simultaneously, the bleeding began to be less impetuous. It gradually diminished, and in ten minutes had ceased altogether. The animal was then shut up, but suffered to move about the room. No bleeding recurred. At the end of twenty-four hours she appeared quite well—moved the limb with freedom, and took food greedily. She was then killed with prussic acid. On examining the limb, it was found slightly swelled. Blood was injected, in small quantity, into the common tissue, and a coagulum had formed in the sheath, around the artery. The upper extremity of the artery was not retracted between the muscles, but was quite superficial. The external coagulum had not exercised much pressure upon it, for its extremity was larger than natural. I dissected the artery from its sheath, to the extent of three or four inches, and opened it longitudinally from above downward. Two inches from the wound I encountered a slender coagulum, which increased in diameter as I traced it downward, and completely stuffed the organ for one inch from its orifice. The external coat presented a lacerated margin, which, however, had become somewhat indistinct by the effusion of lymph. The internal coat was lacerated transversely in many places. Into many of these, slips of the internal coagulum were inserted. The blood which had issued from them appeared to have incorporated itself with that which filled the vessel, and thus to have, at first, attached the coagulum. From many other fissures a very apparent quantity of lymph had been effused—had blended itself with the coagulum and fixed it so firmly in its place that it was difficult to scrape it away. The artery was so firmly stuffed with the coagulum as to be considerably dilated. Not a drop of blood could possibly have escaped from it in this state.

Exper. 2. The carotid artery of a full grown dog, of a large size, was exposed on the left side of the neck, and lacerated as before. The artery broke deep in the chest, and bled for five minutes with great rapidity. The animal then gave signs of fainting, but these soon disappeared and the blood quickly ceased to flow. He was suffered to live for four hours, during which time there was no bleeding. He was then killed, and while dying he struggled very violently, but there was still no bleeding. The chest was then opened, and the artery traced from its origin. It proved to be a branch of the innominata. Its internal coats were broken at its very origin—the external was broken at the distance of an inch and a quarter from the innominata. The internal coats were withdrawn from within the external, which formed a loose pouch projecting from the innominata and stuffed with a firm coagulum. In this case there was no lymph effused, sufficient time not having elapsed. The external coagulum was voluminous and firm, occupying the interstices of the adjacent organs, and extending to the external wound. It had not, however, made pressure enough to interfere with respiration. The cervical portion of the broken artery was hanging from the wound, to the extent of two or three inches. This had also bled freely at the moment of the rupture, but had soon ceased to do so. Its internal coat was ruptured transversely at many places along the trunk of the artery. Near the extremity, it was filled with a coagulum which adhered to the transverse fissures in the internal coat. This must have been, of itself, an effectual barrier against the effusion of blood.

Exper. 3. I procured a horse, twelve years of age, of pretty good constitution, though very lean, and having cast him upon his side, laid bare the carotid. I then passed a smooth iron under the artery and broke it, as I had done in the previous experiments. The blood gushed in a torrent from the wound and in a few minutes the animal lost two or three gallons. In about ten minutes the blood upon the ground began to coagulate, and then a diminution in the rapidity of the current was manifest. The extremity towards the chest hung out at the wound to the extent of three inches. While the blood was flowing rapidly, the

animal moaned once or twice, as if faint; but soon after he rose from the ground without difficulty, and stood till the blood had entirely ceased to flow, which was after about thirty minutes from the time the artery was ruptured. The projecting artery was then returned to its place, and the wound closed.

The animal was suffered to live for twenty-four hours, during which time he appeared nearly as vigorous as before the operation, and took food with avidity. He was then killed by a blow on the head, but, while dying, he struggled very violently. Blood gushed from small vessels in the wound, and I feared, at first, that the obstructions in the artery had given way. But, on examination, I discovered that not a drop of blood had issued from either extremity of the artery. The lower portion of the organ was found perfectly naked, to the extent of three inches from the rupture. Beyond this, its sheath was occupied with a coagulum, as was also the common tissue in the vicinity. No lateral pressure, however, had been exercised on the artery, to impede the passage of blood, as the organ was even increased in volume. The interior of the artery was found firmly plugged with a coagulum six inches long, and completely filling its cavity for nearly the whole extent of the coagulum. The internal coat, as in the preceding experiments, was ruptured transversely at a great many places, and little productions of the internal coagulum were inserted into them so firmly that they must have fixed the coagulum securely, as soon as coagulation had taken place. From many of the fractures in the internal coat, lymph, in quantity, had been effused, and become blended with the coagulum, which was thus so firmly attached to the surface of the organ that it required an effort to detach it. No blood could possibly have passed through it, and, as the coats of the artery every where retained their vitality, no secondary hemorrhage could have subsequently occurred. The accompanying plate accurately represents the preparation which I made of the parts by slitting open the artery longitudinally, and leaving the coagulum in its place. Fig. 1 marks the coats of the artery, near the broken extremity; 2, the coagulum; 3, a point at which the thyroid artery was broken off at its origin, and where the internal and middle coats were lacerated more extensively than at any other part. Here, too, was the greatest quantity of lymph, completely sealing up the organ.



Exper. 4. The carotid of a large dog was laid bare, raised with a hook and divided with a knife. Its extremities then retreated into the sheath. The gush of blood was impetuous, but at the first moment little if any more so than when, in experiment 2, the artery was torn. There occurred no abatement in its force, however, till the animal fainted, which was after five minutes. The bleeding then almost entirely ceased for a moment, but presently returned, and in less than ten minutes the animal expired. The abdomen of this dog was then opened, a hook was passed under the aorta and the vessel was broken. The organ being dissected out, was then examined. Its internal coat was ruptured, precisely as by similar means in the other experiments. In some places it was peeled up from the middle coat, so as to form pockets on the side of the artery; but this was the only instance in which I found any thing of the kind.

Exper. 5. I opened the abdomen of a large dog, and having exposed the aorta above its bifurcation, I attempted to break it in the manner mentioned before. The flow of blood was very rapid, and this, together with the irritation necessarily produced by the exposure of the abdominal organs, rapidly prostrated the powers of life, and the animal died in about five minutes. There was, however, an ineffectual effort at reaction. No other result could have been expected in this experiment, because the bleeding was so copious as to destroy life before coagulation could be

effected. On examination I found that the aorta itself was not ruptured, and that the laceration had taken place in the external and internal iliacs. The blood, therefore, had flowed from several large trunks, a wound of either of which is ordinarily fatal. I was surprised to find, however, that each of the lacerated arteries had its orifice closed with a coagulum which had probably been formed *in articulo mortis*. The internal coat of each was lacerated as in the other experiments, and a portion of the external coat, in every instance, projected beyond the lacerated margin of the internal coats, to the extent of half an inch or more. The extremity of each artery appeared enlarged and bulbous, from the pressure of the coagulum within it, adhering to its rough cellular surface. I was persuaded that, had not the flow of blood been so rapid as to destroy life before coagulation could be completed, this animal would not have perished immediately.

The above experiments will, I think, justify the following conclusions. 1st. That Dr. Jones errs in ascribing the cessation of hemorrhage from lacerated arteries mainly to the same causes which avail against bleeding from divided arteries. In the experiments detailed above, the retraction and contraction of the organ availed nothing. The same was true in regard to the external coagulum, which, according to Dr. Jones, is the principal agent. In each of the experiments, the extremities of the vessel were rather dilated than constricted or compressed. In one instance, (Exper. 3.) the artery hung naked from the wound, and yet the bleeding ceased as promptly as under other circumstances.

2d. Equally untenable is the doctrine that the artery is paralized by the shock inflicted upon its contractile tissue, and that the blood refuses to flow through a passive tube. In every experiment there was extensive injury inflicted upon the artery, and in one the organ was torn from the surrounding parts to a great extent; consequently its vital intercourse with them must have been for a time interrupted, and its own actions suspended. This paralysis of the artery should be most perfect instantly after the injury; but we find that the blood then flowed in a rapid stream which was undiminished till it had had time to coagulate. It is true that in those cases on record in which limbs have been torn from the body, there has been, even at the moment of the injury no considerable bleeding. But this has undoubtedly arisen from the shock given to the general system, and the suspension of the action of the heart till the blood had coagulated in the extremity of the artery.

3d. Although the pockets, or valves, mentioned by Mr. Bell, were, in one experiment, formed on the sides of the lacerated vessel by the rupture and partial detachment of the inner coat, yet, when the experiment was performed on the living animal, they were not found efficient in suppressing hemorrhage in a single instance.

4th. The efficient, and almost only cause of the cessation of hemorrhage from lacerated arteries, is the unequal laceration of the external and internal coats. Generally the internal coat is fractured transversely at numerous places, so as to present an indefinite number of small fissures, into which the blood of the artery is injected, and thence, perhaps, conveyed by insterstitial absorption into the arterial tissues. Blood also probably flows from the ruptured tissue, and mingles with that in the cavity of the artery. As soon as coagulation begins to take place, blood concretes, probably first on the fissures produced in the internal coat, attaching itself to the rough surface which is there produced, and insinuating itself into the insterstices in such a manner that the coagulum becomes so firmly fixed as to resist the impulse of the circulating blood. When an artery is smoothly cut, and the integuity of the inner coat is uninjured, the coagulum finds no point-d'-appui, or roughness upon which it can take hold. The surface is every where polished and lubricated for the very purpose of facilitating the passage of the blood, and therefore the internal coagulum, as it forms, either glides from the artery, when the organ is very large, or perhaps does not form at all, the particles finding no rallying point within the vessel. But when the internal membrane is extensively ruptured, blood must necessarily concrete upon the lacerated surface, precisely as it is uniformly observed to do in other wounds.

In some instances the complete separation of the internal coats will take place at some distance from that of the external, or cellular, which will then hang as a loose pouch from the end of the more rigid middle

coat. Its surface being cellular and lacerated, the blood, rushing along it with force, is injected into this tissue, coagulates upon it, and attaches itself firmly to it. Sometimes it assumes an elongated conical form, being drawn out before its rupture is effected, much like a glass tube, partially fused near its middle and then extended by its extremities. After the internal coagulum has been for some hours attached to the fissures produced in the internal coats, from each one of the ruptures there takes place the effusion of lymph. This still more firmly attaches the coagulum to the internal surface of the organ, and the more effectually stuffs its cavity; finally it takes the place of the coagulum of blood, and obliterates the canal of the artery.

It may be asked, if nature resorts with so much uniformity, precision and effect, to the means of suppressing hemorrhage from lacerated arteries, how does it occur that fatal hemorrhage should so often result from the rupture of arteries which are broken without a corresponding laceration of surrounding parts and of the skin? These injuries are sometimes inflicted on large vessels in effecting the reduction of old dislocations. Many cases of the kind are on record. The probability is that arteries thus yield in these instances, sooner than the surrounding parts, because they are diseased and brittle. The external coat, having lost its extensibility in consequence of the deposition of the lymph in and around it, breaks abruptly without effecting the laceration of the internal coat at more than one place. Besides, we know that when there is no external wound, effused blood does not coagulate with facility, and remaining fluid, opposes no obstacle to fatal hemorrhage. If Mr. Scudamore's explanation of the coagulation of blood be correct, it refuses to coagulate promptly under these circumstances, because it cannot exhale its carbonic acid.*

Punctured Wounds of Arteries.—When a large artery, in a horse or dog, is exposed and punctured with a needle, or similar instrument, blood slowly oozes from the wound—soon coagulates upon its external orifice, and arrests further effusion. If the vessel be reached by the instrument through the sheath, something like a small aneurism will form beneath the latter, but the further effusion of blood being quickly arrested, it soon loses that character and the coagulum is absorbed. In either case, a degree of inflammation results—lymph is furnished—the wound is closed, and if the vessel be examined after the lapse of a few weeks, scarcely any trace of injury will be seen.

Such will, undoubtedly, often be the result of minute punctures thus inflicted on the arteries of man, though the favourable termination is by no means so uniform, traumatic aneurism often taking place, or the artery becoming obliterated in consequence of the high degree of inflammation supervening, and the abundant production of organized lymph.

Contusions of Arteries.—The tunics of an artery may be very seriously injured without the immediate occurrence of the least arterial hemorrhage to betray the character of the organ injured. Without having suffered any solution of continuity which may permit the escape of blood, the coats of the vessel may be so contused, that they will either wholly lose their vitality, and ultimately slough, causing sudden and copious hemorrhage; or, being intensely irritated, they assume so high a degree of inflammation that, by the tumefaction of the injured tissues, the production of lymph, and the attachment of coagula within, they become obstructed and finally closed.

The records of surgery furnish numerous instances of wounds unattended with immediate bleeding, but ultimately producing fatal hemorrhage by the insidious mischief inflicted upon the walls of some important artery. I have recently seen the consequences of such an injury illustrated in a gun-shot wound of the hand. The injury was inflicted by bird shot, but as the hand was placed over the muzzle of the gun at the moment of its discharge, the effect was similar to that of a ball. The charge passed through the carpus on the radical side of the ulnar artery. No hemorrhage occurred at the moment, nor indeed till the slough of the parts which had lost their vitality began to take place, when bleeding, uncontrollable by the compress, took place. I cut for the ulnar artery at the point injured, and, on exposing it, found a breach in its walls on the radial side, evidently caused by a slough of a portion of its tunics. I secured the vessel both above and below the seat of injury.

Mr. Guthrie, in his admirable treatise on the Diseases and Injuries of the Arteries, relates an interesting

* Scudamore on the Blood.

case in which a musket ball made its way between the femoral artery and vein, without producing solution of continuity in either of those vessels, but causing such injury to the tunics of the latter, that a high degree of inflammation resulted;—the vessel became contracted, and filled above and below with coagula, so as to be wholly impervious. The vein was in a similar condition. From these causes the circulation was so interrupted that gangrene of the member followed.

Consecutive Effects resulting from Wounds of large Arteries.—Such are the provisions of nature in the distribution of the blood-vessels, that it is not probable that, in a healthy individual, the interruption of the circulation in any one of the large arteries supplying the members would be followed by grave accidents, were no other mischief suffered than the obliteration of the vessel. But wounds of arteries are invariably attended with more or less injury to the surrounding parts, and these parts are usually important. Large arteries are accompanied with veins and usually nerves, involved in a common sheath; when therefore, the artery is reached by an instrument which produces an incised wound, these organs rarely escape.

When the vessel is attained and injured by a pointed instrument, other parts may escape direct injury, but blood is more or less injected into the cellular tissue around them, and consecutive mischief is the result. For these reasons the wounds of large arteries, whether their bleeding spontaneously ceases, or is suppressed by the ligature, are much more liable to result in gangrene than is the ligature of the same vessel even when applied for the cure of aneurism. Mr. Guthrie relates numerous cases in which such have been the consequences of wounds of important arteries.

When, in consequence of a wound, the circulation has been interrupted in the principal artery of a member, pulsation immediately ceases in all the branches of the vessel;—the limb becomes pallid, colder than natural, has its sensibility impaired, and is partially paralyzed. But although its sensibility to the touch is diminished, there exists a benumbed feeling, and often an aching pain, or sense of general distress in the member, which often renders the patient exceedingly restless. In some instances the signs of vitality gradually diminish till life is extinct in the part, and gangrene manifest. In other instances, after the lapse of a few hours, a greater or less degree of capillary excitement takes place in the limb;—the heat becomes even greater than natural, and pulsation returns in the terminal branches of the artery. The immediate death of the member from defect of the circulation is no longer threatened; but it may still result from the occurrence of gangrene in the wound, the production of this being favoured by the inability of a portion of the parts concerned to sustain inflammation, and institute a healing process. The return of arterial pulsation and of vital warmth is owing to the prompt establishment of a collateral circulation, which being effected, the part gradually resumes its healthy offices though usually continuing for a time flabby and debilitated.

Surgical Means of Suppressing Hemorrhage from Wounded Arteries.

From facts stated in the preceding paragraphs, it is manifest that it is only under very peculiar circumstances that nature is successful in arresting hemorrhage from very large arteries. Indeed, even those of the fourth or fifth magnitude, often, when wounded, either bleed fatally at once, or by exhausting the powers of the system, and injecting blood into the surrounding parts, induce gangrenous inflammation and irreparable destruction of parts; or lastly, become the subjects of aneurism, itself ordinarily a fatal disease unless arrested by surgical means. It is therefore always prudent and generally necessary, that the hand of the surgeon should co-operate with the powers of the system in arresting hemorrhage even from minor branches. Our most important lesson, however, is derived from nature's own efforts. Having learned what the vital powers are seeking to effect, our own endeavours should be made entirely subservient to the same object. The most effectual means which we employ are mechanical, and can only exercise a temporary influence. The ligature, the compress, the cautery, do nothing more than gain time for the completion of a vital process, similar to that which has been already described; otherwise, when these means are removed, bleeding would necessarily recur, and does recur whenever disease defeats the end.

In discussing the treatment of hemorrhage from wounded arteries, we shall find it conveinent to distinguish *primary* bleeding from *secondary*, or *consecutive* hemorrhage. The first is that which occurs instantly on the infliction of the injury. The latter is that which happens after bleeding has once completely ceased, either spontaneously, or under the influence of surgical means.

1st, Refrigerants; 2d, absorbents; 3d, astringents; 4th, escharotics; 5th, ligature; 6th, compression; 7th, torsion; and 8th, the actual cautery, are the several means employed by the surgeon to arrest bleeding from wounded arteries.

1. The German surgeons appear to place an unmerited confidence in *refrigerants* as a means of suppressing hemorrhage, even from large vessels. They expose them for a time to cool air, and dash them with cold water, and they undoubtedly observe bleeding often to cease from vessels which we deem it necessary to ligate. But when warmth is restored in the part, and a reflux of blood takes place, these vessels are liable again to bleed. Cold thus locally applied, is also liable, by suppressing the exhalations of the skin, to produce internal inflammations. When, however, blood issues from many small vessels not conveniently situated for the use of other means, cold may be with propriety resorted to, and will be found effectual. The wound may be exposed to air, the impression of which may be made more active by fanning the part. When we have secured such vessels in a wound as demand the ligature, and arterial blood still oozes from the surface, we may freely expose it to the air, removing the coagulated blood so as to allow this agent to come into immediate contact with the wounded vessels. When bleeding thus ceases, it is much less liable to recur, than when we suppress it by covering and compressing the wound, allowing considerable coagula to remain within it. Air appears under these circumstances to exercise a chemical, astringent influence, as well as a refrigerant one, upon the tunics of the vessels. If exposure to the air proves insufficient, the part may be laved with cold water. .

2. The *absorbents* used in hemorrhage are nothing more than spongy substances of loose texture, such as agaric, lint, &c. which, when applied to a wound, imbibe the blood, give tenacity to the coagulum which forms, and attach themselves by it to the wound. Soft lint is the best material which can be used for this purpose. It may be employed in arresting the slight bleeding of superficial wounds, especially those of the skin, and will, besides, be found in such cases the very best dressing which can be employed. It may be allowed to remain attached till adhesion or suppuration takes place.

3. *Astringents* are sometimes used to suppress hemorrhage, by virtue of the corrugation which they chemically produce in the parts to which they are applied. Numerous agents have been used for this purpose, but it is sufficient to name the diluted mineral and vegetable acids; the solutions of the sulphate of copper—of the sulphate of iron—of alum; alum in substance; various vegetable astringents; the kreosote, &c. &c.

Astringents, or styptics, will only be found effectual in commanding the hemorrhage of small vessels, and such as are inconveniently situated for the use of the ligature, or compress. Scarcely any astringent is more conveniently or effectually used, than powdered alum, sprinkled upon a compress of lint, and applied to the bleeding surface. In the practice of my father, the late Professor of Surgery in Yale College, I once witnessed the arrestation of what threatened to be a fatal hemorrhage, by the introduction of a lump of alum into the wound. A large, deeply seated, encysted tumour had been removed from the throat, and in separating some of its deepest attachments small arteries were divided which it was impossible to reach with the ligature. They continued to bleed guttatim till the patient was nearly exhausted. A lump of alum of half the size of an egg was thrust to the very bottom of the wound, and the bleeding immediately ceased. No mischief resulted from the presence of the alum in the wound, which was soon washed away by the serum of the blood, and by the secretions of the part. The kreosote appears to possess the power of firmly coagulating and condensing blood and the softer solids, and by so doing of arresting hemorrhage more effectually than most other astringents.

4. *Escharotics* and *Caustics* are now but seldom used for the purpose of arresting hemorrhage. They act by disorganizing the bleeding vessel, corrugating and condensing it. They sometimes convert the vessel

and adjacent parts into a pulpy substance which imbibes blood and favours the formation of an adherent coagulum. The first moment after their application blood usually flows more freely, the vessels of the part being excited; but if they are minute they presently cease to bleed. The nitrate of silver is almost the only escharotic now used, and even this is rarely employed but to arrest bleeding from the bites of leeches.

5. *The ligature* is far the most important of the means which we employ for the arrestation of arterial hemorrhage. Its utility, now so indispensable in surgery, is a discovery of comparatively modern date, and yet it is nothing more than the simple tying of a thread upon the extremity of a flexible tube from which a fluid is escaping. But how could the utility of such an agent be appreciated by those who were ignorant of the circulation of the blood—who were even unconscious that the arteries contained this fluid? We must forbear, however, to enter into the history of this and other means which we shall presently name, merely remarking that we are indebted to Celsus for the suggestion of the ligature, and to Paré for its general introduction.

We again recur to the Treatise of Dr. Jones for the most satisfactory information at our command, relative to the agency of the ligature. From numerous and careful experiments he drew the conclusion, that the ligature, when carefully drawn upon an artery, completely severs the internal and middle coats—forces the wounded surfaces into apposition, and mechanically arrests the effusion of blood. The blood within the orifice of the artery, as far as to the first collateral branch, then becomes motionless, except that it slightly undulates from the impulse of the heart and the recoil of the coats of the artery. The first result of the application of the ligature is the formation of a coagulum extending as far as the first branch—slender and at first inadequate to fill the artery, because of the agitation which the blood suffers. "But the formation of the coagulum is of little consequence; for soon after the application of the ligature, the extremity of the artery begins to inflame, and the wounded internal surface of its canal, being kept in close contact by the ligature, adheres and converts this portion of the artery into an impervious and at first slightly conical sac."* The internal coagulum is no where attached, except at the extremity of the artery, and through the medium of the effused lymph. While the extremity of the artery is thus becoming sealed, lymph in the meantime is effused between and into the coats of the organ to some extent from the extremity, causing them to become thickened, and thus to encroach upon the calibre of the vessel. Externally, also, lymph is deposited in such quantity as to envelope the extremity of the artery, leaving merely a small canal around the projecting end of the ligature. After some days the thread occasions ulceration of the portion of cellular coat constricted by it, and is discharged from the part. The small sinus which it leaves is soon filled with granulations. The tissue immediately around the artery is left dense and thickened from the deposition of lymph. The vessel, after a variable length of time, is at length obliterated as far as to the first branch. The same increase of size and function takes place in the collateral branches as in case of spontaneous suppression of hemorrhage.

Dr. Jones states that he has seen no effusion of lymph within the artery, after the application of the ligature, except at the cut margins of the internal coats, and, consequently, that no closure can be effected unless these coats be severed by the thread. Hence he infers the absolute necessity of using a small, firm, round ligature, and of drawing it so closely as to ensure the division of the internal coats. We cannot doubt, however, that, as reported by other careful experimenters, lymph is sometimes effused from the irritated and inflamed surface of the internal coat, as from serous membranes, in sufficient quantity to effect the obliteration of the vessel. When, therefore, a larger and softer ligature is employed, merely for the purpose of pressing together and irritating the internal surface of the artery, the end will often be accomplished. Scarpa was fearful of the mischiefs which might result from the division of the internal coats, and the too rapid ulceration of the external from the close constriction of a small ligature. He therefore recommended larger and softer cords, and that they should often be applied with an intervening pledget of lint. Reflection and

* Treatise on hemorrhage, by J. F. D. Jones, M. D. p. 160.

experience both reject the innovation. There is, first, less certainty that lymph in sufficient quantity will be effused; secondly, as the parts embraced by the ligature must become in some degree indented, even by its gentle pressure, the thread may soon cease to press the opposite sides into contact; thirdly, not embedding itself in the substance of the artery, the ligature is liable to lose its hold upon the vessel, and to be thrown off; fourthly, if it should not slip from the extremity of the organ, it retains its hold too long, not exciting the ulceration which is necessary to effect its release.

If there be an objection to tying the artery loosely, then is it obviously unsafe to include in the ligature any of the surrounding parts, since they must necessarily defend the organ from the close constriction of the thread. Besides, the more voluminous the parts included are, the more severe must be the irritation which this agent produces—especially as nerves and veins, highly sensitive organs, are always situated in the vicinity of arteries. It is equally unsafe to denude the organ of its cellular envelope, to any considerable extent. It is from this that the artery derives its nutrient vessels, and in the recuperative process which is to follow, it requires the exercise of all its vital qualities.

Care should also be taken that the cord be tied transversely upon the artery, and not obliquely, as sometimes results from seizing with the instrument but one side of a large artery and withdrawing it unequally, in consequence of which the ligature embraces too much, and does not cut with facility, or nicely purse together the margins of the internal coats. Care should also be taken in drawing the knot, which should be single and repeated, that the thread may slip, without doubling upon itself; for this reason, that which is termed the surgeon's knot, in which there is a double implication of the thread before it is drawn, is the least safe for the surgeon's purposes. It also causes too much friction, so that the organ is not easily constricted, and it is more difficult to feel the division of the internal coats, in drawing the thread. Ordinarily, the sudden yielding of the internal tunics of a large artery is distinctly felt, and may determine the necessary degree of force. In applying the ligature to the carotid, in the living subject, I have perceived the yielding of the coats in the most distinct manner. The ligature may be of silk or linen—should be small and round, and sufficiently strong to endure as firm a pull as the fingers of the operator can bear. It is impossible to prescribe the precise degree of force necessary, but there is little danger of too close constriction, as the external coat will never be severed when healthy. Keen pain is usually felt on tying the ligature.

It is only when the arterial tunics are diseased that we disregard the above precepts. Sometimes, from chronic disease, the external coat becomes as brittle as the internal. When such is the fact, its unnatural rigidity is generally obvious to the touch, and when the ligature is closely drawn upon the naked vessels it is often completely divided, or subsequently gives way and occasions secondary bleeding. In an amputation below the knee, performed in the Baltimore Infirmary, September, 1828, I found the coats of the posterior tibial so brittle, that the ligature several times cut away the extremity of the organ. Under such circumstances, our dernier resort is to include with the artery, in the grasp of the ligature, some of the surrounding tissue, which may thus serve as a compress, and to defend the tunics. The ligature should then be large and be drawn firmly, but not violently. In the case just alluded to, I was compelled to use the needle in conveying the ligature around the artery. This is sometimes termed the mediate ligature.

In some rare instances, when the parts surrounding a wounded artery are confounded, by complicated injury, the bleeding vessel cannot be distinguished. Then, also, it may be justifiable to plunge the needle beneath its supposed situation, and include some of the surrounding parts. Such a resort, however, is generally to be regarded as a reproach to the surgeon.

For seizing and drawing out the artery, in the application of the ligature, the common tenaculum is ordinarily the most convenient instrument. Sometimes, however, it is not easy to transfix the artery, and forceps may be used to seize the organ with more precision. I have used an instrument of somewhat peculiar construction for this purpose. The common artery forceps often have a slide, for the purpose of compressing the blades and holding the artery securely, while the ligature is applied.

The instrument here represented has a spring

projecting from the inside of one of the blades, and passing through a hole in the other. On this spring there is a catch, which, when the blades are firmly compressed, takes hold of the blade which it pierces, and keeps the instrument closed. Its peculiar utility consists in the operator being able, when he has caught the organ with his forceps, by gently pressing the blades, to fix the instrument by merely increasing the pressure, instead of employing both hands, as is necessary in moving the slide, and which is very apt to disengage the forceps. The blades are excavated just above the points, in order that they may be less apt to slip from the organ, and that any small substance getting between the blades, may not defeat the seizure of a small artery. This instrument is very convenient when assistance is not at hand. The weight of the forceps will drag out the artery, while the surgeon applies the thread.

When a bleeding artery lies deep and is inaccessible to the hand, and it is necessary to pass a needle beneath the organ, various forms of the port-aiguille are employed. Generally, the simple forceps and needle of Dr. Physic will be found sufficient.*

When, from the narrowness of the wound, the surgeon is embarrassed in finding the organ, it is infinitely better at once to dilate the wound, than to irritate the parts by ineffectual endeavours. The adhering coagula should also be carefully removed, and a sponge in the hand of an assistant should be from time to time pressed upon the supposed seat of the vessel and removed with a quick motion so as to exhibit the orifice of the vessel as the blood makes its first spring. By gently drawing the convex side of the tenaculum over its seat, we may in a similar way determine its precise situation.

Sometimes, as blood continues to flow from an artery in some deep recess of the wound, a coagulum gradually accumulates upon the walls of the wound, around the stream, which, however, by its impetus, keeps open a canal for itself that becomes continuous with that of the injured vessel. Under these circumstances, the operator often believes that he has the orifice of the artery near the surface, and is not undeceived until, with the tenaculum, he makes repeated attempts to seize, and as often breaks away a portion of the coagulum. Hence the imperative necessity of clearing away with the finger-nail, or handle of the scalpel, every portion of the coagulum which obscures the artery.

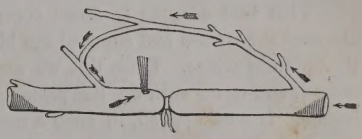
Sometimes we are deceived in regard to the situation of the bleeding vessel by a reflection of the current. The stream issuing forcibly from the vessel, is projected against the opposite side of the wound, and then issuing, seems to come from a point directly opposite to where the bleeding orifice really is.

When an artery is but partially divided, it should be immediately cut across, for reasons which have already been given. In case of mere puncture of the temporal artery, I have seen a hemorrhage which compression could not control, instantly suppressed by dividing the organ. When the artery is very small, this expedient will alone often be sufficient.

There is no precept more important in relation to traumatic hemorrhage, than that which, in wounds of large arteries, enjoins the application of a ligature to each extremity of the divided organ. When the orifice towards the heart is alone secured, blood, after a short time, enters the trunk below, from anastomosing branches, and flows rapidly in the retrograde direction—the more rapidly, because the parts will then have become morbidly excited. To expose and thus secure both orifices may, it is true, be often a matter of extreme difficulty, in consequence of the injection of the cellular tissue with blood—perhaps the effusion of lymph, the inflammation and swellings of the organs, and the change in the relative position of parts Often, too, the jet of blood will not direct us, as the artery may bleed only at intervals. It is very often observed to cease for a time as soon as the parts are irritated by the touch of instruments. If it be a considerable vessel, however, the judicious surgeon will not be deceived by this treacherous intermission. His knowledge of the parts, and the direction of the wound must govern his hand. Occasionally it may be necessary to seek the vessel above the wound, and to trace it down to the point of injury. There is far less to be feared from the most extensive incisions in the direction of the muscles, than from the forcible injection of blood among the organs. The utmost caution is to be observed that the ligature be not applied very

* Dorsey's Surgery.

near to the origin of a large branch, as the continued impulse of the blood flowing through the latter, will generally defeat the sanative efforts of nature, or break up the incipient adhesions when the thread shall have been detached.

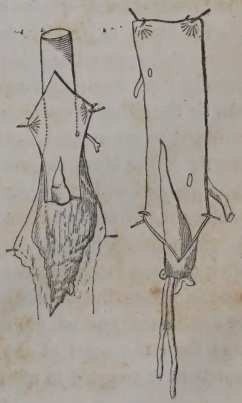


The accompanying cut illustrates the recurrent bleeding which takes place when, for the suppression of hemorrhage from a partially divided artery, a ligature is only applied above the orifice. It also illustrates the formation of the collateral circulation.

When the application of the ligature is completed, one of the extremities of the thread is to be cut close, and the other to be drawn out at the wound. Some have advised that both extremities be cut close to the knot, in order that the wound may be closed, and as little foreign substance as possible be left to defeat union by the first intention. I can merely remark here, that such is not the practice of the best surgeons of the present day, except when animal ligatures are employed.* The knot of a ligature accidentally left after the amputation of the breast, has, in my own practice, within the past year, greatly protracted the perfect cicatrization of the wound, and caused much anxiety in the mind of the patient.

When a cavity is opened, and a viscus is protruded and wounded, there is an important objection with some to the employment of the ordinary ligature. When the viscus is returned, it drags with it a quantity of thread into the cavity, where, by coming in contact with an extremely sensitive membrane, it inflicts more irritation than in other wounds. Here, too, healing by the first intention, is exceedingly important. Under such circumstances, therefore, surgeons have recommended the employment of animal ligatures, which may be cut close to the knot, and the organ returned without danger of mischief, because, being a substance congenial to the parts, they excite but little irritation, and, at length, may be completely absorbed. Some surgeons recommend the use of animal ligatures under all circumstances; but to this there occurs the objection that, being too inflexible before they are immersed in water, and too soft afterward, they do not so effectually cut the internal coats. Besides, when applied to a very large artery, there is danger that they may undergo decomposition before they will have accomplished their object. I do not speak from personal observation, however, as I have rarely employed them.

The use of the animal ligature is much more common with English and American surgeons than with those on the continent of Europe. The Parisian surgeons, (Beclard, &c.) report unfavourably in regard to their use, absorption of the knot by no means uniformly taking place, and small abscesses being often occasioned by it.



The accompanying engravings illustrate the spontaneous suppression of hemorrhage, and also the agency of the ligature in effecting the closure of an artery. In the first figure, the artery, removed from the animal a few hours after the division, is represented laid open longitudinally; the cellular sheath, to which the external coagulum is attached, is seen extending beyond the well-defined margin of the proper coats of the artery. The internal coagulum extends along the expanded internal surface of the artery nearly as far as to the origin of a small branch.

The second figure exhibits the ligature applied, and the conical coagulum, smaller than the canal of the artery, its base sustained by the ligature, and its apex extending upward beyond the first branch.

5. *Compression*, next to the ligature, is the most important of the means by which we arrest arterial hemorrhage. The material, or compress, employed is usually either lint, sponge, or folded linen. Sometimes harder substances, such as wood, are used with more effect. In its application, the object is either to press together the walls of the vessel and obliterate its

* Lawrence on a new method of tying arteries in aneurism, Med. Chirurg. Trans. vol. vi. p. 156.

cavity; or to sustain the external coagulum, and assist the efforts already being made by nature. We employ direct, or indirect compression. It is *direct* when applied immediately to the orifice of the bleeding vessel;—*indirect* when applied laterally to some portion of the vessel a little way from the wound.

That best adapted to direct compression, is the graduated compress. In using it, having carefully cleansed the wound and exposed the bleeding vessel, we apply a small ball of lint, or sponge, directly upon the bleeding orifice. Upon this we apply another a little larger, and still over this a third, broader than the second, and so on until the last piece applied rises above the level of the borders of the wound. To this a bandage is then applied, in such a manner as to make continued pressure. The compress will then have a conical form, its base receiving the pressure of the bandage, and its apex imparting it to the bleeding vessel.

It is of the utmost importance that if possible the compress should be applied with precision to the very orifice of the vessel. It is surprising how slight a pressure will command bleeding when thus applied. But when a broad compress is applied over the entire wound, and considerable soft parts intervene between it and the vessel, all the pressure which can be endured by the patient will often fail to effect the object. The cause will readily be appreciated by any one acquainted with the principles of hydrostatic pressure. Where a fluid flows from a small tube into a closed vessel, however great may be its capacity, the pressure made upon every point of the surface of the walls within, will be precisely equal to that with which the fluid rushes from the tube into the vessel. A cask, of even great strength, may be readily burst, if, when it is filled, a small tube is fixed tightly in it by one extremity, while the other is elevated several feet, and water poured into it till it is filled. Nevertheless, if to the lower extremity of the tube a finger be applied, there is no considerable effort necessary to arrest the current of the fluid. An artery pouring blood into a wound may be regarded as in some respect analogous to the apparatus alluded to. If the extent of the surface of the wound within be a hundred times as great as that of a section of the artery, then will the general amount of pressure caused within it by the accumulation of blood be one hundred times greater than that made at the extremity of the vessel; and it is manifest that to arrest bleeding it will require a hundred times as much pressure if it be applied to the walls of the wound, as it would if it be applied to the orifice of the vessel alone. After extirpating a tumour from the back where the integuments are very strong, and closing the wound accurately with sutures and adhesive strips, I have known the blood flowing from a small artery to distend the walls of the wound with so much force as to cause the sutures, in two hours, to cut through the skin.

When a compress is applied externally, it becomes necessary to bind it so tightly in order to arrest the blood, that the compress itself is made ultimately to produce the very effect which it is designed to obviate. The pressure soon creates irritation,—the part becomes painful, hot and pulsatory, and a copious afflux of blood is made to it. All the vessels in the neighbourhood are excited to increased action, and hemorrhage occurs, although an equable pressure be continued, or even although it be increased. I have often seen blood gushing from beneath a compress tightly bound upon a wound, and have seen it promptly cease to flow as soon as the dressings were all removed, and the wound opened and relieved of all irritation. Although the compress when applied externally will often fail to arrest bleeding from a small artery, yet when applied directly to the bleeding orifice it will sometimes command the most important vessels. In two instances I have arrested with it bleeding from the femoral, beneath Poupart's ligament, when the ligature had been used for the cure of aneurism and copious secondary bleeding had occurred.

Sometimes, however, as a dernier resort, we are obliged to use the compress externally. For instance, when copious bleeding occurs from the nose, and other means fail, we plug the anterior and posterior nares; but sometimes the distension within becomes so great, and irritation so severe, that convulsions occur, or are threatened, and we are obliged to remove the plugs. We sometimes, in the same manner, arrest hemorrhage from the orbit of the eye, or from the maxillary sinus, and with very doubtful propriety the same expedient is resorted to after lithotomy, and to arrest bleeding from the rectum.

When the compress is used for the purpose of arresting hemorrhage from many small vessels, it is well to dust it over with the powder of alum, or other astringent. A compress which has been introduced into a wound to arrest bleeding should not be removed until suppuration has commenced; but the pressure made upon it by the bandage may be relaxed after a few hours, lest irritation should result.

The temporal artery,—the maxillary, where it passes over the margin of the jaw,—the radial,—the dorsal artery of the foot, &c. are conveniently situated for this purpose. Lateral compression, however, even when effectual in arresting hemorrhage, is often attended with so much pain in the sensitive parts around the artery, participating in the pressure, that it cannot be endured by the patient until nature shall effect the closure of the vessel.

The material with which we make lateral compression is usually sustained by the circular bandage, but to this in many cases there obtains the objection, that it obstructs the circulation in other vessels, especially veins, impeding the return of blood. This is particularly liable to occur when a large artery of one of the extremities is concerned. To obviate this difficulty in the use of lateral compression, means have been resorted to which confine the pressure more completely to the artery.

Lateral compression is sometimes made with the fingers, only however while preparation is being made to secure the vessel with the ligature, or during the execution of an operation. With the fingers, the assistant feels the pulsation of the vessel, and thus determining its situation with precision, compresses with the more effect. In this mode of compression, the three first fingers of the right hand should be applied in a line along the course of the vessel, while (if it be the artery of an extremity) the thumb is applied as nearly as possible at an opposite point. Sometimes, in order to render the pressure more firm, it is necessary to apply the fingers of the left hand over those of the right. Sometimes the thumb is employed, especially for compressing the subclavian and femoral arteries in amputations. It is of the utmost importance that while, during an operation, compression is being made with the fingers or thumb, the member should in no degree be moved from the position in which it is fixed at the moment the compression is commenced;—also that the patient be steadily supported during the operation. The principal objection to this method of commanding an artery, is that the struggles of the patient and the action of the muscles near the vessel, may alter the relations of the parts and throw off the fingers from the vessel. Such an accident not long since occurred to me during an amputation, and much blood was lost.

A counting-house seal,—a key, wrapped with linen; or a piece of wood, of a shape adapted to the size of the vessel and the form of the parts, is occasionally employed instead of the fingers or thumb. The objection to such instruments is that the assistant does not feel with it the form and pulsations of the vessel, and therefore cannot direct his compression with necessary precision.

The *tourniquet*, of which we have already had occasion to speak as sometimes a necessary adjuvant in the application of the ligature, is another form of the compress. This instrument, now so familiar to surgeons, was first used by Morel; but the form most generally employed is that of Petit. It is unnecessary that we should describe an instrument which may be seen in all amputating cases. It is chiefly useful for the purpose of compressing arteries of the extremities, and this it accomplishes by ligating the whole limb with a strap which encircles it, and which is tightened at will with a screw. The pressure, however, is made more effectual over the artery by a pad, which is attached to the instrument, and which is adjusted over the vessel.

A much more simple apparatus, effecting the same object, is the field tourniquet, or *garrot* of the French. A handkerchief and stick are all that is absolutely necessary for its application. At the place when the artery is designed to be compressed, the limb is loosely encircled by the handkerchief, and a firm knot is tied on the side opposite to that where the artery is felt. A stick, of the size of the thumb, is now thrust beneath the knot, and being grasped by the hand, is made to revolve by turning the hand, and thus the handkerchief is twisted upon itself beneath the knot, and made to constrict the limb with any degree of tightness that may be desired. Care must be taken that the integuments be not pinched in twisting the handkerchief.

That form of this apparatus termed the "garrot" is thus applied. A firm cylinder of linen is placed over the course of the vessel. Over this a long compress is applied, so as to encircle the limb, and its two ends cross each other on the side opposite to the cylinder. Over this last a band of soft woollen is loosely applied in the same direction, and its extremities are firmly tied at a point opposite to the cylinder. A piece of horn, or hard leather, is now to be inserted beneath the knot, to protect the skin, and then the stick is thrust between the horn and the knot. The stick is now grasped and made to revolve as before.

To every form of the tourniquet, however, there exists the objection that it compresses not merely the principal artery of the limb, but all other vessels, and especially the veins, so that the member is strangulated, a condition of the parts which cannot be endured for a considerable time without serious mischief. It is only employed therefore to restrain hemorrhage, during amputations, till the arteries can be secured; or, when large arteries are wounded, till more permanent means can be resorted to.

Instruments have been devised by different individuals for the purpose of compressing the artery of a member, without ligating the whole limb as with the tourniquet. The compressors of Freer and Blizard were used with this intent. That of Dupuytren is perhaps the best instrument of the kind which has been employed. In form it somewhat resembles Hull's truss. It is composed of a stiff plate of steel, curved so as to form two-thirds of a circle. At one extremity there is attached a broad and concave pad which is to form the point d'appui, that is to give effect to the pressure of the second pad. To the other extremity of the instrument a second, small cylindrical pad is attached, and furnished with a screw so adapted as to enable the operator to increase its pressure at will. In applying the instrument, the operator fixes the concave pad on the member, upon the side directly opposite to the seat of the artery. The cylindrical pad is now brought over the vessel to be compressed, and by turning the thumb-screw the pressure is made and gradually increased, until pulsation in the artery ceases.

8. The *actual cautery* has been employed for the purpose of arresting arterial hemorrhage from time immemorial, and at one period was the most effectual means known to surgeons of controlling the hemorrhage of large arteries. The severe character of the remedy, and its inefficacy, compared with the ligature, now forbid its employment except in those cases in which other means are inapplicable, or in which the cautery is employed for a double purpose. We are sometimes compelled to resort to the cautery for the purpose of arresting hemorrhage from wounds of the tongue, or gums,—after extirpation of the eye—operations upon the maxillary sinus—the extirpation of hemorrhoids, &c. &c. After the use of the knife, in the extirpation of diseased parts, wherever situated, we sometimes resort to the cautery for the double purpose of suppressing hemorrhage from small vessels, and subverting diseased action in the surrounding parts.

The form of the iron employed will of course depend upon that of the part to which it is to be applied. It should be heated to whiteness, and in applying it the surgeon should carefully deterge the wound of blood with a sponge held in one hand and, at the moment of its removal, touch the orifices of the bleeding vessels with the iron. It is important that the cauterization should be thorough, and in some instances it is necessary to employ more than one iron. If the iron be intensely hot, it instantly kills that which it touches, and, as a brief application is then sufficient, irritation is not excited in the surrounding parts. But if the temperature be lower, the pain from its application must be more severe—the bleeding vessels are less effectually closed, and the application being protracted, adjacent parts are burned and inflamed without being killed. Secondary bleeding is then liable to occur, and is difficult of control because the cautery will have rendered it difficult to discern the bleeding vessel.

9. *Torsion*, or the twisting of an artery, is a means of arresting hemorrhage in the smaller arteries, which recently has been almost simultaneously recommended by M. M. Thery, Amussat and Velpeau. The object is to place the vessel in the condition of a lacerated artery, and then to rely on the process of nature. Torsion is effected by seizing the vessel with forceps a little above its orifice, drawing it out, and then seizing its extremity with another forceps and twisting it twice or thrice round. I have often practised it, after operations, upon small arteries the bleeding of which forbade the closing of the wound, but to which I was reluctant to

apply the ligature. Usually I have merely seized them with a single forceps, and severely twisted and pinched them. For an instant I have generally observed that the bleeding is increased by the irritation thus produced, but soon it entirely ceases.

When, after an amputation, or in the treatment of a considerable wound, we have used all the means deemed necessary to arrest bleeding, it is proper that we should delay the final dressing until re-action has taken place, and the circulation has been restored, and till blood ceases to flow from small vessels. M. Dupuytren, in the Hotel Dieu, adopted the practice of not applying the final dressings till after some hours, merely wrapping the parts in loose coverings. Hence there rarely occurred the necessity of stripping off the permanent dressings, and tearing open the wound when adhesions were commencing—a necessity as reproachful to the surgeon as it is perilous and painful to the patient.

Secondary Hemorrhage.

It not unfrequently happens that when, after an operation, or in the treatment of a wound, all the arteries which are seen to bleed are secured and the wound closed, (perhaps prematurely,) bleeding is repeated on the restoration of warmth in the part, and the occurrence of re-action. Or, perhaps, from the mode of dressing, or other cause, there occurs irritation in the wound, causing an undue afflux of blood, and the consequent effusion of it. Or, finally, in consequence of a diseased condition of the vessel, or vessels, to which the ligature is applied;—because of the vessel being denuded of its cellular tunic,—or owing to an ulcerative process in the wound, or sloughing of parts, hemorrhage occurs at a much later, though variable period, after the first dressing.

When bleeding results from the too early closure of the wound, as the flow of blood is generally from small vessels, we may often command it without removing the dressings, by directing pressure to be made with the hand for some time. If, however, the flow is considerable, the wound must be opened and the vessels secured, especially if we ascertain that coagula of considerable volume have accumulated in the wound. When coagula form, of such volume as to distend the wound,—put the adhesive strips on the stretch, and render all the dressings painfully tense, they become a source of severe irritation, and although the bleeding which caused them to form may have been at first a mere oozing, yet when they begin to produce these effects, the bleeding is usually greatly increased, nor will it often cease till these coagula are removed. I have several times had occasion, on account of bleeding, to open wounds which were stuffed with coagulated blood, and I have frequently seen the hemorrhage cease spontaneously as soon as the coagula were completely removed.

In dressing a wound from which arterial hemorrhage has occurred, care should be taken to impose no irritating constraint upon the parts, and to leave them in that state of repose which is favourable to the process of union. Whatever creates irritation in such a wound, renders it a centre of fluxion. Sutures so applied as to create painful traction are a frequent source of secondary bleeding, as I am confident from frequently having seen the bleeding to cease the moment the stitches were cut. Even adhesive strips, when they painfully drag the skin, are productive of similar effects. I have in several instances known the compress, applied for the very purpose of suppressing hemorrhage, to be the cause of its repetition. When the compress is so closely bound as to create irritation, a painful throbbing is felt beneath it, and blood will often gush from under it notwithstanding its pressure. There recently fell under my observation a case of wound of the palmar arch, in which such was manifestly the effect of the compress. The vessel had been wounded by a stab with a broad-pointed knife, and the attending physician not being able to secure it with the ligature, applied a small firm compress in the palm, exterior to the wound. In three or four days, bleeding recurred, and was arrested by binding the compress still more firmly. Extreme pain arose from its severe pressure, the patient was rendered restless, and bleeding again occurred. Again the pressure was increased with a similar result. I saw the patient on the 14th day, and the moment I entered the room, a little mental excitement being produced by my presence, I saw the blood gush from beneath the dressings. I found

them bound with extreme tightness, and the patient complaining much of their pressure. I removed them as quickly as possible, and found that the compress had produced, at one point, a slough of the integuments, and a high degree of inflammatory excitement around. No sooner were the parts at ease, than the bleeding, which before was impetuous, so suddenly ceased that the current was hardly sufficient to reveal the situation of the artery, and enable me to secure it. Had the compress in this case been graduated and so placed within the wound as to press gently, but directly, upon the orifice of the bleeding vessel, I doubt not that it would have been effectual.

In all these cases in which hemorrhage appears to have been kept up by irritation, every cause of such state should be removed, and soothing applications be made to the wound.

When secondary hemorrhage results, in consequence of a diseased condition of the artery to which a ligature has been applied, the process by which nature is expected permanently to close the vessel, will often be defeated, and bleeding occurs whenever the ligature effects the division of the vessel. This event may happen at almost any period after the application of the thread, till the ordinary time of its separation from a healthy vessel. From vessels of the smallest size requiring a ligature, in a healthy state, the thread will separate in three or four days; from the largest, such as the carotid, subclavian and iliac, it will not usually separate before the 14th, and will often remain later.

When a ligature separates prematurely from a diseased vessel, if it be not a vessel of large size, it is better not to attempt its re-application, but to resort to other means. The actual cautery may often be then resorted to, by the agency of which not only will the present bleeding be arrested, but a new and more healthy action be induced. The graduated compress, moistened with a solution of the nitrate of silver, may be used with similar intent.

Sometimes, when secondary bleeding occurs under these circumstances, a partially organized coagulum will be found in the wound, which, by continuity with the margins of the wounded vessel, prevents its closure, and forms a kind of spongy, bleeding tissue. Such coagulum should always be carefully removed, and the action of the part changed.

When a large artery is prematurely cut by the ligature, it must be secured at a higher point, where it may be presumed to be more healthy; but when the arteries are known to be generally diseased, it may be advisable to rely upon the graduated compress, and especially if the hemorrhage be not impetuous. There are many cases on record in which hemorrhage have occurred on the separation of the ligature from large arteries, without fatal consequences. In these cases, although the process of nature may not have been complete, so as to prevent the effusion of blood on the separation of the ligature, yet it will often have so far progressed as to render the compress more effectual than if it were applied to a recently wounded vessel. I have already alluded to two instances in which, after the separation of the ligature from the femoral artery, I have commanded the copious hemorrhage which resulted by the compress alone.

Sometimes the ligature remains attached an unusual length of time, and having partially divided the artery, allows hemorrhage to take place. Whenever the ligature does not spontaneously separate at the usual time, it is well to facilitate its separation by making traction on the thread by winding it round a piece of bougie or other small cylinder, and by turning this till the string is rendered tense, and confining it with an adhesive strip.

Organic Diseases of the Arteries.

The close investigation of modern pathology has ascertained, that the arterial tunics are more susceptible of diseased action than was once believed. It is true that, from the peculiarity of their structure, they do not readily participate in the diseases of surrounding organs. Ulceration often makes extensive ravages around the arteries and leaves them untouched. Specific ulceration, however, is occasionally imparted, so as to open their cavities; and intense inflammation, which results in the sphacelation of surrounding parts, involves also the arteries. But far the most numerous and interesting diseases of the arteries are their own

primary affections, which take their character from the peculiar structure and vital qualities of their coats. Like all other vascular tissues, the arteries are liable to both chronic and acute inflammation, and to the organic changes which result from these forms of diseased action.

Acute Inflammation of the Arteries.—The arteries have long been observed to be occasionally the primary seat of inflammation, but the modern mode of pathological investigation, founded on the distinction of the tissues, has revealed many interesting facts in relation to this subject. One of the most successful cultivators of this department of pathology is M. Gendrin, of Paris, in his Anatomical Description of Inflammations.* This writer informs us that, when acute inflammation is excited by an irritant introduced into an artery, there will first be seen, between the internal and external membrane, a tissue of injected capillaries. As diseased action progresses, however, these vessels disappear, while at the same time the internal membrane becomes rough, villous, soft, brittle and pulpy. From the internal coat there also exudes a body of lymph, which may at length completely fill the organ. The middle tunic becomes thickened and is converted into a cellular substance of a yellowish-red hue, very moist and exceedingly friable. The vessels in the internal layer of the cellular tunic also become the seat of inflammatory engorgement, but the external layers retain their healthy condition. Sometimes pus is deposited, but rarely, in the interior of the organ. Small collections of this fluid are formed in the cellular coat, or between the tunics, and it is occasionally blended with the lymph which exudes from the inner coat.

There are sometimes seen on the internal surface of the arteries, after death, patches of a bright violet tint, which Corvisart supposed to be the result of inflammation. They arise, however, merely from the imbibation of blood which stagnate in the vessel, and are readily distinguished by the absence of all other evidences of inflammation.

Sometimes the arteries derive their acute inflammations from intense diseases of the viscera in their vicinity, an instance of which is related by M. Bertin.† Sometimes they are excited, by wounds or by the application of the ligature. In some rare instances they probably are idiopathic.

The arteries are so deeply seated, and their vital qualities so obscure, that the signs of acute inflammation in them are not easily discerned. When, however, the organ can be approached with the hand, the artery, along its tract, will feel hard, like a cord;—there will be pain and tenderness along its course, and its pulsation will become obscure; but there are none of those external signs of inflammation which occur in phlebitis. The vital functions of the member supplied by the artery will be impaired, and its sensibility obtunded. There will also occur a much higher degree of constitutional irritation than results from ordinary phlegmon, but it is less severe than in phlebitis.

Acute inflammation of the arteries is to be treated with the usual depletory means, especially local blood-letting and counter-irritation.

Chronic Inflammation of the Arteries—is of far more frequent occurrence, and more interesting in its results, than the acute. The organic actions in the inner coats of the arteries, seem not to be performed with so much vital energy as in many other tissues. The properties by which the larger arteries exercise their functions are chiefly physical, like those of the bones—the cartilages—the ligaments; consequently, as in these organs nutrition is peformed with less power than in more vascular tissues, whenever the nutrient functions are impaired by any cause which may prevent the healthy assimilation of the fluids, or weaken the organic actions of the system generally, defective or irregular action is liable to take place in these tunics. In extreme age, the arteries become ossified, as do the cartilages. In scorbutic, syphilitic and scrofulous diseases, in which the function of nutrition is especially impaired, the arteries, like the bones, the ligaments and the cartilages, undergo organic degeneration which predisposes them to disease; hence they are prepared to become the seat of the specific inflammation which belongs to one or other of these affections. Chronic

* Histoire Anatomique des Inflammations, chap. vii. sec. 2, 3, 4.

† Traité des Maladies du Cœur et des Gros Vaisseaux.

inflammation of the arteries is rarely seen except in habits depraved by general disease, and then generally occurs simultaneously in many parts of the arterial system.

Chronic inflammation of the arterial tunics is characterized by a greater degree of thickening than occurs in the acute, and by redness of greater or less intensity. After some time, the internal tunic assumes a reddish brown hue, and there are formed on its surface plates of a grayish or bluish colour, more or less thick, of brief extent, and depressed. These are portions of the tunics, condensed and indurated, and which at length become cartilaginous, or fibro-cartilaginous. In other parts, the coats are observed to become soft and pulpy. Here and there they present vascular ramifications, and points of ossification. Small abscesses are also formed in the substance of the arterial coats. The walls of the arteries become so much thickened that their calibre is often greatly diminished, and the circulation impeded. Small eminences more or less numerous and prominent are seen upon the internal surface, these are formed of a dense and indurated tissue, which may at last become cartilaginous or bony. These changes, as M. Gendrin remarks, must be the result of inflammation; because they often exist simultaneously with ulceration, which is always preceded and accompanied by inflammation.

Ulcerative (*phagédénique*) *Inflammation of the Arteries.** This form of disease attacks the arteries more frequently than the veins, and is only known to occur in the great trunks. It is always chronic—or the result of acute inflammation supervening upon chronic. The ulcers produced are of a round form. Around the border of each, the usual characters of acute or chronic inflammation are present. They first effect the removal of the internal coat; next, they erode the middle coat, which will also have become the seat of inflammation. They by no means so frequently effect the disorganization of the cellular tunic, this membrane either becomes indurated and fortified by effused lymph, so as to resist ulceration, and the impulse of the blood; or, being still pliant, it yields to the impulse of the blood which is insinuated beneath it in consequence of the erosion of the inner coats, and becomes converted into an aneurismal sac. Yet sometimes the cellular assumes the diseased action of the internal tunics and is eroded in the same manner, in consequence of which, death may at once result.

Degeneration of the Arterial Tissues. There is a kind of degeneration from unhealthy nutrition of the arterial tunics, which precedes chronic inflammation. In depraved habits, whether strumous, scorbutic, venereal or rachitic, the arteries are often found to have lost in a degree their proper physical and vital qualities. The internal membrane loses its polish, and ceases to secrete the lubricating fluid; it becomes thickened, pulpy and brittle. The middle tunic loses its elasticity, and also becomes rigid and brittle. The external, though reluctantly, often undergoes the same morbid changes. Such a condition of the arteries is often observed in our dissecting rooms, in those subjects which have suffered long from morbid nutrition. Sometimes the organic actions may have become so feeble, that the arteries will have become converted into calcareous tubes by the deposition of an earthy substance in their tunics. Dr. George Lynn, of Virginia, informed me of an instance in which this degeneration took place, even in infancy. Disorder of the assimilating functions had existed for a long time, and, after death, the arteries were found to have been almost universally converted into earthy tubes. It is sometimes difficult to determine whether organic degeneration has been the cause, or the effect of chronic inflammation. At all events there is a reciprocal influence, and where chronic inflammation has supervened, the degeneration of the tunics becomes much more rapid. We have already spoken of many organic alterations resulting from chronic inflammation. Besides the thickening, softening, or induration of the tunics, earthy incrustations, tuberculous excrescences, purulent depots and ulcerations, Mr. Hodgson informs us that morbid granulation sometimes takes place within the organ—that atheromatous accumulations are formed beneath the internal coats, in cavities which are at length opened by ulceration—that the calcareous incrustations formed on the internal coat sometimes cleave off and become floating obstructions in the arteries—that sometimes the whole canal of a large artery becomes obliterated by the deposition of a curd-like matter.

* Histoire Anatomique des Inflammations, par. A. N. Gendrin, chap. vii. sec. 4.

The signs of chronic inflammation and of organic degeneration of the arteries are obscure—the more so because they are often the result, either of irreparable disorder of some important organ, or organs, concerned in the process of assimilation, or the gradual impairment of nutrition from age. Sometimes, however, morbid changes in the coats of the arteries are the first visible link in the train of morbid phenomena. When the arteries lose both their elasticity and contractility, become rough within, and unequal in their calibre, it is obvious that the blood must pass sluggishly through them. If it be true that the capillaries at all times aid in bringing forward the blood through the arteries, they must, under these circumstances, be called upon for unwonted action in obtaining their supply of that fluid, and hence the indirect exhaustion and extreme irritability which, in the extremities, terminates often in the variety of gangrene described by Mr. Pott. If it is not the mere withholding of blood which always produces this result, as very often the extreme vessels obtain enough of this fluid for high inflammatory action.

Dengeneration of the arterial tunics from chronic inflammation may also terminate in aneurism. Of this disease I briefly treated in the former edition of this work, but as I found it impossible to furnish a complete account of it within the space which, in a work devoted to the surgical anatomy of the arteries, could with propriety be devoted to it, I have in this edition omitted it altogether.

Drawn on Stone by S. Smith.

C. Wildig's Lith.

PART II.

SPECIAL ANATOMY OF THE ARTERIES.

SECTION I.

ARCH OF THE AORTA, AND ARTERIES OF THE HEAD AND NECK.

THE AORTA.

The great trunk of the systemic artery arises, opposite to the cartilage of the left fourth rib, from the right posterior and superior angle of the left ventricle of the heart. Its origin is in front of the ostium venosum, and, obliquely on its right and in front, it has the right auricle assisting to conceal its root. On the right is the cava descendens. Viewed from before, the artery is seen emerging from between the auricle and the pulmonary artery, having, at the distance of an inch from its origin, gained this situation by inclining to the right, and decussating the pulmonary artery, which, arising from the left superior angle of the right ventricle, inclines to the left in a corresponding manner. These great vessels appear, indeed, as if twisted upon each other, like the strans of a rope. We cannot better illustrate their local relations, than by imagining these organs to have issued from the heart, parallel with each other, and then the heart to have been grasped and contorted to the left. The ventricles and auricles of the heart also partake of the contortion. Thus the great vessels and the distinct compartments of the heart, are made so to embrace each other that they are effectually sustained, and all tendency to separation or displacement during the systole of the heart is prevented.

The proper arterial tunic of the aorta touches the heart only at three equidistant points, and between these its margin is so cut away that it presents three festoons, the convexities of which look toward the ventricle. A more perfect continuity of parts is effected by the passage of the lining membrane of the ventricle into the aorta, and its becoming continuous with the internal tunic of that organ. This membrane, being pressed outward beneath the festoons of the elastic coat, forms the sinuses of Morgagni; and by certain duplicatures, it also forms the semilunar valves, the description of which rather pertains to the anatomy of the heart. The connection is also fortified by the inner lamina of the pericardium, which is reflected over

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Index to Plate I.—In this view, the Heart is seen in its natural relative situation, also the great arterial trunks, their primary branches and many of the adjacent organs. No. 1 marks the right Ventricle of the heart; 2, the left do. 3, the right Auricle; 4, the left do. 5, the Aorta; 6, the Pulmonary Artery; 7, section of the Pericardium; 8, Arteria Innominata; 9, right Carotid; 10, right Subclavian; 11, left Carotid; 12, left Subclavian; 13, Trachea; 14, Thyroid Cartilage; 15, Thyroid Gland; 16, Sterno-thyroid muscle; 17, Sterno-hyoid; 18, Omo-hyoid; 19, anterior Scalenus; 20, Clavicle, 21, first Rib; 22, common trunk of the Thyroid, Cervical and Scapular Arteries; 23, the Thyroid Artery; 24, the Vertebral; 25, the Superior Scapular; 26, the Anterior (or ascending), and Posterior Cervical Arteries; 27, the Pleura; 28, the descending Cava; 29, the Lungs.

the origin of the aorta upon the heart. When the aorta has disengaged itself from the pulmonary artery and right ventricle, it ascends more directly, bending at first a little forward, then to the left and backward. Its course is therefore spiral. Between the third and fourth dorsal vertebræ, it emerges from the pericardium, and occupies the middle of the vertebral column. Ascending as high as the second dorsal vertebra, it directs itself a little backward and to the left, almost transversly, thus forming the *arch of the aorta*, which terminates opposite the left side of the third dorsal vertebra, and above the pulmonary artery. Here the aorta becomes vertical, and descends directly along the left side of the spine.

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Of the Aorta. It is obvious from the manner in which nearly two inches of the origin of the Aorta are embraced by the pericardium, enclosed in the same cavity with the heart, and in a degree insulated and distinguished from surrounding organs, that it must be with the heart that it is most intimately associated in disease. When aneurism occurs in this portion, the pericardium reflects the tumour upon the heart, and hence it is often difficult to distinguish aneurism thus located from diseases of the heart. It is obvious that the tumour must also hinder the free dilatation of the right auricle, and impede the passage of blood through the pulmonary artery. When the disease thus situated at length results in rupture, the contents are generally thrown into the cavity of the pericardium, and instant death occurs.

But it is after the aorta has emerged from the pericardium, that it becomes most obnoxious to the causes of disease. The arch of the aorta is more frequently the seat of organic derangement than any other portion of the arterial system. It is this which first encounters every violent and irregular impulse of the heart when disturbed in its action, and which thus protects the more remote branches. It does this the more effectually because of its abrupt curvature; but, for the same reason, it is itself exposed to more violence. It is apparent that the current of blood from the heart will dash with greatest force against the upper part of the arch, which, indeed, for this reason, is provided with thicker walls than other portions. Nevertheless, it is the most frequent seat of disease. In aged subjects—even those that have never given evidence during life of disease of the great blood-vessels, it is by no means uncommon to find the upper part of the arch uniformly dilated. This is because, from the feeble exercise of the nutrient functions, it loses its properties of texture, becomes inelastic, and ceases to recover itself after the impulse of the heart. How is it then that the circulation is undisturbed, since it is believed that the elasticity of the aorta is necessary to urge on the blood which is sent from the heart? When thus dilated, the aorta borrows elasticity from the lungs, the walls of the chest, and other adjacent parts, against which it is pressed in its dilatation, and which recoil upon it during the diastole of the heart.

Dilatation of the aorta, (Aortaektasis,) is distinguished from aneurismal distension by the greater abruptness of the latter, and its being usually confined to a smaller, and more defined portion of the vessel. It also presents the aspect of a tumour implanted upon the artery, whereas dilatation presents merely the appearance of preternatural enlargement. In dilatation also, there are wanting those layers of lymph and coagulated blood which invest the internal surface of the walls of an aneurism. Sometimes the dilated aorta, especially when it expands in a sac-like form, assumes a remarkable size. Scarpa has observed it to measure eight inches in height and five in diameter.

As dilatation is invariably preceded by some change of texture in the tunics of the vessel, it is manifest that the disease is allied to aneurism, and may often terminate in it. When dilatation is extreme, the symptoms caused by its mechanical pressure upon the surrounding organs may be identical with those which occur in aneurism. There will, however, be less of the aneurismal thrill, and less impediment to the circulation. The stethoscope will furnish the best diagnostic criteria.

Aneurism of the Arch of the Aorta.—The arch of the aorta having its anatomical relations with very important organs, and those so situated and confined that they cannot recede from pressure, aneurisms of the arch must seriously modify their form and embarrass their functions—more so, indeed, than aneurisms of the descending thoracic, or abdominal, aorta. The trachea and bronchia may be compressed and dyspnœa produced;—the œsophagus may suffer;—the heart and lungs may be compressed or displaced, and their functions embarrassed;—the vena cava, vena azygos, transverse vein, and even the great branches of the aorta may seriously suffer. The important nerves of this region, and the thoracic duct are equally obnoxious. Lænnec saw a case in which, the thoracic duct being compressed, the lacteals became remarkably engorged. The increasing tumour at length encounters the walls of the thorax, and, first distending,

The arch of the aorta rises to within about ten lines of the top of the sternum. It has the vena cava and the lung on the right; and in front, the mediastinum, between the laminæ of which it lies, attaches it to the sternum. Above and in front, the great transverse vein passes. The summit of the arch crosses the trachea just above its bifurcation. As it descends, the artery embraces in the concavity of its arch the left pulmonary artery in front, and left bronchius behind.

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at length destroys them, and protrudes from the cavity; or it issues from the thorax behind the sternum, and displays itself upon the neck, as indeed is most frequently the result when the arch is the seat of the disease.

But it is not by mechanical pressure alone that the neighbouring organs suffer from aneurismal tumours of the thoracic aorta. Inflammation is either excited by pressure, or imparted from the tumour, and adhesions follow—or softening and ulceration take place, and perhaps the blood of the aneurism is poured into the cavities of the hollow organs. Aneurisms of the ascending portion are very liable to burst into the cavity of the pericardium, in consequence of the great tenuity of the cellular coat in that portion of the artery; or they may discharge themselves into the left pleura, which they do much more frequently than into the right, because of its closer proximity. Sometimes they adhere to the lung and by the ulcerative process discharge themselves into the bronchia.

An aortic aneurism has been known to adhere to the pulmonary artery, and by ulceration to establish a communication between the two great arteries, thus producing all the phenomena resulting from the admixture of venous and arterial blood. In the same manner have these aneurisms been known to discharge themselves into the vena cava and into the right auricle.

Usually the rupture of an aortic aneurism is instantly fatal. When it bursts externally, it is loss of blood alone which threatens life. During its flow, however, a contained coagulum may lodge itself in the opening, and for a few hours the fatal result may be suspended. When the aneurism opens into the pericadium, pleura, or trachea, it is manifest that, although the escape of blood is impeded, yet, to the loss of it from the circulation, are added the grave accidents which arise from its presence in the organs named, the functions of which may be fatally embarrassed. Even then, however, the fatal result is sometimes delayed for a few hours.

The symptoms of aortic aneurism are by no means so clear and expressive as the distinct character of the disease would appear to promise. From the pressure of the tumour upon the trachea, there will almost necessarily occur dyspnœa, and stridulous breathing. The voice, too, may be lost, or modified, a peculiar roughness often occurring, and sometimes a feeble whispering voice. From pressure upon the œsophagus will arise dysphagia; from pressure upon the vena cava there often occurs an œdema of the face and neck, and engorgement of the vessels of the brain threatening apoplexy. There have also been observed a turgid or varicose state of the veins of the chest, and unusual pulsations of the veins of the neck.

Smallness and inequality of the pulse in the two arms, and perhaps its extinction in one of them, have been regarded as presumptive proofs of aortic aneurism. Dull or lancinating pains; an occasional sense of distension, or laceration behind the sternum are sometimes felt. Numbness and pain in the shoulder may arise from pressure on the brachial plexus of nerves. To these signs may be added occasional vertigo; tinnitus aurium; disposition to syncope; epistaxis; cough; hæmoptysis; pulsatory sensations behind the sternum, and throbbing of the carotids. A dull sound on percussion—a purring tremor when the hand is applied to the sternum are recognized by Corvisart and Elliotson as occasional symptoms.

Among all these symptoms, however, we have not named one which is not equivocal,—not one which does not frequently arise from other causes of disease. All those which we have named as arising from pressure, may occur in an equal degree from any other tumour located behind the sternum. The morbid pulse may arise from disease of the heart. Nothing can be more delusive than the sensations experienced by the patient. All the symptoms which we have named may be absent, and yet aortic aneurism, in its incipiency, may exist.

The least equivocal signs of aortic aneurism are derived from auscultation. When the stethoscope is applied over the supposed seat of the tumour, usually a single loud and forcible impulse is perceived, synchronous with the pulse. This pulsation, it is true, is liable to be confounded with that of the heart, and especially when this organ is diseased. The pulsation of the heart, however, is double and as the ventricular impulse is alone synchronous with the pulse, it is

The Coronary Arteries, (Arteriæ Coronariæ)—are designated as right and left.

The Right Coronary arises from the aorta just above the floating margin of one of the semi-lunar valves, on the right of the pulmonary artery. In a tortuous course, it traverses, outwardly, the fissure which separates the right auricle from the corresponding ventricle, until it half-encircles the organ, and reaches a groove which runs along its posterior part longitudinally. Here the artery divides—one division pursuing the groove to the apex of the organ—the other, continuing transversely between the left auricle and ventricle, finally descends on the thick edge of the heart to its extremity. Throughout its whole track, this artery is constantly giving off branches, at convenient points, for the supply of the aorta, the pulmonary artery, and the right auricle and ventricle. The descending branch gives ramuli to the posterior walls of the two ventricles, and penetrates the septum; the circular branch supplies a portion of the left auricle and ventricle and the left margin of the heart, anastomosing with the left coronary.

The *Left Coronary Artery*, the smaller of the two, issues from the root of the aorta, on the left of the pulmonary. It passes downward, forward, and a little to the left, emerging from beneath the appendix of the left auricle and insinuating itself into the anterior or longitudinal groove, which it pursues along the septum to the apex of the heart. This artery also sends filaments to the aorta and the pulmonary artery, to the left margin of the heart, and numerous twigs to the septum and anterior walls of the ventricles.

From the convexity of the arch of the aorta there arise the three large and important branches, which the systemic trunk here gives off to supply the superior regions of the body, before it completes its curve to commence its descent. Such is the oblique position of the arch, that the Arteria Innominata, which is first in order, is anterior and on the right—the left Carotid is in the middle, and the left Subclavian behind and on the left. Sometimes, there arises from the summit of the arch, between the first and second great branches, a small artery (the middle, inferior thyroid) which ascends directly along the trachea to the thyroid gland. Sometimes, instead of three, there are four great branches from the arch of the aorta, there being a right

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this and not the auricular which is liable to be confounded withthat of the tumour. But the pulsation of the tumour is more loud, hoarse, and abrupt. It resembles the rasping of a sounding board heard at a distance. The sound caused by valvular disease of the heart more nearly resembles the bellows-murmur, heard through the stethoscope.

Diagnosis is sometimes rendered the more difficult by a double sound in the aneurism, as well as in the heart; but, by care, error from that source may be avoided. In exploring the aneurismal sound from its principal seat toward the heart, it is found to decrease till it disappears, or is lost in the ventricular sound. If the sound were from the heart, it would increase as the organ is approached. The second sound heard over the aneurism, *does* thus increase as we approach the heart, and being similar to the diastolic sound heard in the præcordial region, is identified as the disastolic sound of the heart.

When an aneurism of the arch of the aorta rises from behind the sternum, and issuing from the chest, displays itself in the neck, its character as aneurism is sufficiently manifest; but its particular seat is not even then easy to be determined, as we learn from the memorable case related by Allan Burns.

Wounds of the Arch and ascending portion of the Aorta. From its magnitude, its obliquities, and its curvature, it is obvious that the aorta must present broad surfaces both laterally and anteriorly, which are obnoxious to injury in penerating wounds of the thorax.

Incised wounds of the aorta must necessarily prove immediately fatal,—even more rapidly so than those of the heart; but after small punctured wounds, the fatal result has been known to be delayed for several days, and it is possible that even recovery has taken place in such instances, though satisfactory evidence of such fact must ever be wanting. Berard in the Dict. de Med. has related the most remarkable cases of wounds of the aorta not attended with immediately fatal results. Among them is one instance in which, not only the aorta was pierced, but also the right auricle of the heart wounded, and yet the patient survived eleven days.

The possibility of recovery after a slight wound of the aorta, would, in any case in which such injury was suspected, justify endeavours to aid the efforts of nature, by enjoining perfect repose of body and mind even for weeks—by the frequent abstraction of blood,—and by confining the patient to an unstimulating regimen.

carotid and right subclavian instead of the arteria innominata; or, the vertebral (ordinarily a branch of the subclavian) arising directly from the arch.

Arteria Innominata. This great branch arises from the arch directly in front of the trachea—ascends obliquely on the right of this organ, beneath the vena innominata, and after a course of an inch and a half, divides opposite to the sterno-clavicular articulation into two great arteries—the right carotid, and the right subclavian. When these arteries arise directly from the aorta, the root of the second is often beyond the origin of the left subclavian. To gain the right side, it often dips beneath the trachea and passes behind it. In one instance I have known it to pass behind the œsophagus also, in close contact with the spine. Mr. Harrison notices the same arrangement.

Anteriorly, the arteria innominata is covered, first by the par vagum and right cardiac nerves;—then by the terminations of the internal jugular, subclavian and thyroid veins, and by the origin of the cava

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ARTERIA INNOMINATA.

For a more particular account of the diseases of the aorta than can with propriety be here given, I would refer the reader to an admirable article (Aorta) in the American Cyclopedia of Practical Medicine, by Professor Geddings.

Arteria Innominata. This vessel is the frequent seat of aneurismal enlargements. Often the disease is imparted to it from the aorta, and very rarely is it the seat of aneurism independently of disease in that vessel. Dilatation of the innominata will cause direct pressure upon the trachea, rendering respiration difficult; also on the left vena innominata, which crosses it, and on the origin of the vena cava which is on its right, impeding the return of venous blood. As the tumour becomes large, it re-acts upon the aorta and detrudes it from its place. At length it may emerge from the thorax—either ascending directly above the centre of the sternum, between the sterno-hyoid muscles, and carrying before it the duplicature of the cervical fascia, which fortifies this region; or, as is most frequently the case, following the course of the carotid or subclavian, and appearing behind the inner extremity of the clavicle. Aneurism of the innominata may often be distinguished from that of the aorta, by the aneurismal thrill of the pulse being confined to the right side, and by the pulse on this side being weaker than on the left.

The innominata is sometimes wounded by oblique thrusts from above the sternum. Sometimes the vessel is much longer than we have represented, rising, before its division, on the front of the trachea, above the sternum. When this is the case it is endangered in operations upon the trachea. Instances of its being wounded in this region are on record. In one instance this vessel was wounded by a medical pupil in Paris, in performing the operation of tracheotomy upon his companion, in a state of asphyxia from drowning.

It is not probable, although predicted by high authority,* that the ligature will ever be successfully applied to the Arteria Innominata. Its shortness, its magnitude, its depth, its proximity to the heart, are all circumstances of a very unpropitious character. In two instances, however, this important vessel has been secured with results less quickly disastrous than might have been expected. In the case of Professor Mott, of New York, the first on record, the patient survived till the 26th day, hemorrhage having resulted from ulceration of the vessel after the separation of the ligature. In the case of Græfe, of Berlin, the subject survived four weeks, and then perished from hemorrhage in consequence, as the operator believed, of his removing the serre-nœud too soon, at the moment when success was on the point of being achieved. Similar circumstances would justify a repetition of the attempt, and it is therefore necessary that surgeons should study the best method of accomplishing the application of the ligature.

Professor Mott's case furnishes us with but little instruction in this respect, as the operation was begun with the intention of applying the thread to the subclavian, and was therefore somewhat complicated. Mr. Harrison recommends the following mode of procedure: The patient is to be placed in such an attitude that the head may be bent backward, and the artery thus as much withdrawn from the thorax as possible. An incision, two inches in length, is then to be made along the anterior edge of the sterno-mastoid, terminating at the sternal end of the clavicle; from which point another incision is then to be made, an inch and a half long, above the clavicle, and parallel with it. The flap, consisting of the integuments and platysma, must then be raised, and the sternal portion of the sterno-mastoid exposed, which, being raised on a director carefully introduced so as to avoid the small vessels situated below, is then to be severed from within

* A. Burns, on the Head and Neck.

superior, these veins and the artery being enveloped in a strong fibro-cellular lamina; next, it has in front of it the origins of the sterno-hyoid and sterno-thyroid muscles; then the sternum,—the head of the clavicle and the tendon of the sterno-mastoid muscle. Posteriorly it is separated from the trachea by some lymphatics and cellular tissue. On the right the pleura very closely approaches it.

Common Carotid Arteries. (Arteriæ Carotides Communes.) It is already obvious that the com-

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outward. The sterno-hyoid and thyroid muscles, after removing a little cellular tissue, will then be exposed, and are to be divided in a similar manner. The lips of the wound being then widely retracted, and some cellular tissue removed, the carotid is seen arising from the innominata, and conducts the operator to the latter vessel. The ligature is then to be applied in the manner which we shall presently describe. This method does not essentially differ from that of Mr. Guthrie.

A method, however, more feasible, as it appears to me, and one which I have often practised on the dead subject, is recommended by Professor M'Clellan, of Philadelphia, in the third volume of the American Medical Recorder, 1820.

Besides the relations of the innominata which we have already described, the surgeon should call to mind that, on the front of the trachea, above the innominata, the inferior thyroid veins, two in number, descend to the great transverse vein. Over these lie the inner edges of the sterno-hyoid and thyroid muscles, united by intervening tissue, and overspread by the deep fascia of the neck described by Mr. Burns. Over these lie the sternal origins of the sterno-mastoid, between the edges of which, and over their surfaces, the superficial fascia passes.

Dr. McClellan recommends to reach the artery by one linear incision, made vertically, directly upon the centre of the trachea. The integuments, the superficial and deep fascia, are first to be divided;—then the thyro-hyoid muscles to be separated and retracted—the thyroid veins to be exposed, and that on the right side to be pushed towards its fellow of the left. Sometimes, as we have described, a middle inferior thyroid artery passes up in this place to the thyroid gland, from either the innominata or the aorta. This is also to be avoided, if it exist. Then the muscles on the right being strongly retracted, the root of the carotid is seen, and guides the finger to the innominata. The sheath of the latter vessel is then to be cautiously divided, and the vessel denuded by a careful use of the handle of the knife. Lastly, the ligature is to be conveyed around the artery; and the best instrument, in my opinion, for so deeply seated an organ, is that invented by Dessault, and figured in Velpeau's Surgery. Bellocque's, or Weiss' instrument might also be conveniently used.

This method was practised by Professor Richard W. Hall, September 7th, 1830, in a bold attempt made to secure this vessel on a patient in the Baltimore Infirmary, labouring under subclavian aneurism. The operator appears, in his account of the case, given in the Baltimore Medical and Surgical Journal, No. 1, to have exposed the vessel without difficulty, by an incision such as I have described. In consequence of the diseased and friable condition of the vessel, however, we infer that his attempt to pass the ligature was unfortunate. From the report of the autopsy, by Dr. Caleb Jones, it appears that "the ligature which was left in the wound was found to pass through two holes in the coats of the arteria innominata; these openings, which were two or three lines in diameter, and nearly resembled each other, were about six or eight lines apart, and were situated in the anterior, or internal part of the vessel." It is manifest, therefore, that the artery must have been transfixed by the aneurism needle. It is easy to imagine that such an accident might arise from the doubling of the enlarged and diseased artery upon itself, when pressed by the finger, so that the interstice between the folds should be mistaken for that which separates the vessel from adjacent parts. I have known the femoral artery to be thus pierced by the aneurism needle. The case of Professor Hall furnishes the interesting fact, that the patient, with this double wound of the innominata, survived nearly five days after the operation.

It is a circumstance not a little in favour of this mode of operating, that surgeons so emphatically advise us not to extend our incision too low in performing tracheotomy, lest we should wound the innominata. This would seem to indicate that this great vessel is accessible especially in this direction. But the mode of operating must be in some degree determined by the change of relations resulting from the disease which renders the operation necessary. The surgeon will sometimes find every precept set at nought, and must then act *pro re nata*.

Common Carotid. Wounds of this great artery are generally at once fatal. This results, not only from the rapid arterial hemorrhage which occurs, but in part from the injury generally inflicted upon the jugular vein and par vagum

Drawn on Stone by S. Smith

Geo. Hagg's Lith.

mon carotids—right and left, are by no means symmetrical, since one arises from the innominata, and the other from the aorta. Their primary relations must also differ.

The *Right Carotid*, from its place of origin already named, ascends almost directly to the space between the os hyoides and the superior margin of the thyroid cartilage, where it divides, and is resolved into the external and internal carotids. In their ascent, the two common carotids diverge from each other and incline backward, so that, although at their origin they are in front of the centre of the trachea, and very near to each other, yet in their course they pass quite behind the plane of the trachea, and, at their termination, are widely separated by the larynx. The right carotid is covered at its origin by the co-incident origins of the sterno-mastoid, hyoid and thyroid muscles—by the platysma myoides, the fasciæ of the neck, and the skin. As it ascends it passes beneath the omo-hyoid muscle, where that organ emerges from beneath the sterno-mastoid, at the distance of three fingers' breadth from the sternum. At the same place the artery escapes from beneath the latter muscle, and, for the remainder of its course, is covered merely by the fascia, the platysma and the skin. Behind, it rests upon the longus colli and rectus capitis muscles. As the artery courses along the trachea, it crosses the inferior thyroid artery, and slightly dips beneath the lobe of the gland. Higher still, it has upon its inside, first, the larynx, and then those pharyngeal muscles which arise from the larynx. Externally, the common carotid is bounded by the great internal jugular vein, and behind the plane of these two organs, in the angle formed by their juxtaposition, the par vagum nerve is lodged. The artery, nerve, and vein are involved in a common sheath of great thickness and strength. On the surface of this sheath, in front of the artery, the descendens noni nerve passes down the neck. A chain of glands extends along the outside of the sheath of the vessels, under the border of the sterno-mastoid muscle, and bound down by the cervical fascia.

The *Left Carotid* arises from the arch of the aorta, beyond the origin of the innominata and on the left of the trachea. It is covered at its origin by the vena innominata, the remains of the thymus gland, and by the sternum. It is somewhat longer than the right, a little smaller, and less superficial where it enters the neck; but, above, its relations correspond to those of its fellow, already described.

The External Carotid Artery, (arteria carotis externa) extends from the place of its origin, to the neck of the condyle of the jaw, where it is resolved into the temporal and internal maxillary. At the bifurcation of the common carotid, the external is on the inside, and but little more superficial than the internal. But in their ascent these arteries appear as if twisted spirally upon each other—the external becomes really such, crossing the other obliquely outward, and the internal, winding beneath it, gains the deeper situation. The two arteries insinuate themselves beneath the digastric muscle, just where

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Index to Plate II.—Plate ii. represents a superficial dissection of the Arteries of the Neck, Head, and upper region of the Chest. 1, is the Sternum; 2, the Pectoral Muscle; 3, Deltoid; 4, Clavicle; 5, Latissimus Dorsi; 6, Serratus anticus; 8, Triceps; 9, Coraco-brachial; 10, Teres major; 11, Sterno-mastoid; 12, Omo-hyoid; 13, Scalenus anticus; 14 Scalenus posticus; 15, 16, Levator Scapulæ; 17, Splenius; 18, Trapezius; 19, Sterno-hyoid; 20, Sterno-thyroid; 21, Os Hyoides; 22, Digastric and Stylo-hyoid; 23, anterior belly of the Digastric; 24, Masseter; 25, Buccinator; 26, Depressor ang. or.; 27, Depressor labii; 28, Zygomatic. major; 29, Zygomatic. minor; 30, Levator ang. oris; 31, Levator labii; 32, Levator of lip and nose; 33, Compressor naris; 34, Orbic. or or.; 35, Orbic. palp.; 36, 37, Occipito-frontalis; 38, Parotid Gland; 39, Duct; 40, Sub-max. Gland; 41, Larynx; 42, Trachea; 43, Brachial Nerves; 44, Subclavian Artery; 45, Superior Scapular; 46, Transversal. Colli; 47, Superficial Cervical; 48, Ascending Cervical; 49, 50, Branches of the Acromialis; 51, 52, Acromialis; 53, Brachial; 54, C. Carotids; 55, 56, E. and I. Carotids; 57, Thyroid. sup.; 58, Lingual; 59, Facial; (the Pharyngeal seen between the carotids;) 60, Occipital; 61, Masseteric; 62, Sub-mental; 63, Facial, ascending; 64, Inferior Coronary, and just below it, In. Labial; 65, Sup. Coronary; 66, Lateral Nasal; 67, Nasal branch of the Ophthalmic; 68, Frontal; 69, Temporal; 70, Transversalis Faciei; 71, Anterior branches of T.; 72, Auricular branches of T.; 73–4–5, Sup. branches of T.; 76, Occipital continued; 77, Auricular. On the chin, the remains of the Dental A. are seen issuing from beneath the depressor muscle. Between the two origins of the sterno-mastoid, a branch of In. Mammary issues.

they are crossing each other. The external carotid then ascends, inclining backward to the angle of the jaw, and following the posterior edge of its neck, buries itself beneath the parotid gland, in front of the ear.

Below, the external carotid is covered only by the skin, platysma, and cervical fascia; but, as it ascends, it merges itself beneath the hypoglossal nerve, and beneath the muscles and glands which we have named. At its middle, it has the stylo-pharngei and stylo-glossi muscles on its inside, and, still higher, the styloid process in the same relation. The External Carotid gives origin to eight branches in the following order; 1, Superior Thyroid; 2, Facial; 3, Lingual; 4, Occipital; 5, Auricular; 6, Inferior Pharyngeal; 7, Temporal; 8, Internal Maxillary. Sometimes there are the Mastoid and Transversalis Faciei.

The *Superior Thyroid*—arises from the very root of the external carotid—sometimes from the common carotid at the point of its bifurcation. It curves abruptly downward, forward, and inward, to the side of the larynx—then it passes directly downward, in a tortuous course, to the summit of the corresponding lobe of the thyroid body. In this route it is covered by the platysma—the sterno-hyoid and the sterno-thyroid muscles, to which, and other adjacent organs, it gives ramuli

Laryngeal—is the first considerable branch of the preceding, very near its origin. It passes transversely inwards, behind the thyro-hyoid muscle, and along the thyroid membrane, giving twigs to it and to neighbouring muscles—some also which inosculate with corresponding ramuli of the other side. It then pierces the membrane, in company with the internal laryngeal nerve, and within the larynx is resolved into branches which are appropriated to the arytenoid muscles, and in numbers to the mucous lining of the larynx and epiglottis.

The Crico-Thyroid—smaller than the preceding, is sent downward and forward over the thyroid cartilage, giving twigs to adjacent muscles, and thence transversely over the crico-thyroid membrane, to anastomose with its fellow of the other side.

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nerve, which are involved in the same sheath. But sometimes a pointed instrument pierces the artery alone, making but a slight external wound. The blood which flows then escapes with difficulty, and time is obtained for the application of the ligature.* The upper and the lower portions of the carotid are very equally protected; for although, as we have described, the lower portion is covered by muscles, it is near the front of the neck and but little protected by the trachea; whereas the superior portion, although it is very near the surface, retreats behind the level of the trachea and larynx, and uses them as its shield, so that these organs being pushed forward upon the vertebræ, then rendered convex and prominent, have sometimes been completely divided by the knife of the suicide, while the great vessels have escaped. This is more apt to occur because the instrument is almost always directed upward—very obliquely in regard to the vessels.

The application of the ligature to the common carotid, (first successfully performed by Mr. Fleming, and next by Mr. Abernethy,) has now become a familiar operation. There are two regions of the neck, in either of which it may easily be performed;—the one below the omo-hyoid muscle, the other above it;—the one termed by Velpeau the omo-hyoidean region, the other the omo-tracheal. The former is eligible when aneurism exists above, and we wish to tie the artery as remotely from it as possible. The latter, above that muscle, is chosen when there exists aneurism or vascular sarcoma above the bifurcation, or a wound in that region. In either case it is important to determine the point at which the omo-hyoid muscle crosses beneath the sterno-mastoid. This may be done by stretching a thread from the anterior part of the mastoid process to the middle of the sternum—another from the side of the body of the os hyoides to the middle of the clavicle. While this is done the head should be gently inclined backward. The point at which they cross indicate that at which the artery emerges from beneath the two muscles, bisecting the angle which they form with each other. Another line, drawn from this point to the angle of the jaw, will indicate the direction of the artery.

In cutting for the artery beneath the omo-hyoid, the head is thrown back and to the opposite side, to render distinct the margin of the sterno-mastoid, along which, but a little within it, an incision is then to be made from a little above

* Hemorrhage may be restrained for a few minutes by pressing the carotid directly back upon the cervical vertebræ on which it is supported.

When it reaches the thyroid body, the thyroid artery divides into three branches, one of which insinuates itself between the gland and the larynx, and a second skirts the outer border of the gland. Both of these anastomose with branches of the inferior thyroid artery. The third follows the inner edge of the gland, over the cricoid cartilage, and anastomoses with a similar twig from the other side.

The *Lingual* (Arteria Lingualis,)—arises, next in order, from the front of the external carotid, behind the digastric muscle—sometimes by a common trunk with the facial. It ascends, then winds inward and forward plunging between the hyo-glos. and the constrictor pharyn. med. muscles; then ascends between the hyo-glos. and genio-glos. muscles—between the latter and the sub-lingual gland, above the horn of the hyoid bone, to the root of the tongue. There, becoming the *Ranine*, it runs horizontally to the tip of the tongue, between the genio-glos. and lingualis muscles. The lingual sends twigs to all the adjacent muscles, but is resolved into three principal branches—the *Dorsal*—the *Sublingual*—the *Ranine*.

a. The *Dorsal*—arises beneath the hyo-glos. muscle—directs itself upward and forward to the base of the tongue, and to the epiglottis, also sending branches to the tonsils and the veil of the palate.

b. The *Sub-lingual*—arises on the genio-glos. muscle. It passes horizontally forward, between the mylo-hyoid and the genio-glos. above the sub-ling. gland, giving branches to these organs, and to the mucous membrane of the mouth. This artery is sometimes a branch of the sub-mental.

c. We have already described the course of the *ranine* to the tip of the tongue. In its passage it is just above the frænum, and, at its termination, it anastomoses with its fellow.

The Facial Artery (Arteria Maxillaris Externa)—springs from the external carotid above the lingual, behind the digas. muscle, and passes transversely inward and forward. After a tortuous course, in which it dips beneath the hypoglossal nerve—the digastric and stylo-hyoid muscles, and the sub-maxillary gland, it gains the inner part of the angle of the jaw. It then turns back, between the gland and the base of the bone—curves again, is wrapped around the side of the jaw at the margin of the masseter muscle, and

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the passage of the omo-hyoid, to near the sternum. This divides the skin and platysma. It is then to be deepened through the fascia. This membrane is here very strong—adheres to the sheath, and has beneath it some small veins. It must therefore be divided cautiously, and by first introducing the director beneath it. The inferior margin of the omo-hyoid is then found, and directly beneath it lies the artery in its sheath, partly covered by the margin of the sterno-mastoid. The omo-hyoid muscle is to be carefully retracted upward and outward, and for this purpose it may be necessary to divide a slip of fascia attached to the inferior margin of its tendon. The sheath is now to be opened by seizing with the dissecting forceps a small fold of it, elevating it, and slightly incising it horizontally, sufficiently to admit the point of the director. The latter instrument is then to be introduced, and the sheath to be divided upon it to the necessary extent. In effecting this step of the operation, we should avoid that part of the sheath which is directly over the internal jugular vein, lest we wound that vessel, or so liberate it from its coverings that it will expand and interpose itself in front of the artery. If we cut directly upon the centre of the carotid, the descendens noni is exposed to injury. It is expedient, therefore, to open the sheath opposite to the inner border of the artery. If the sheath be not freely opened the ligature is effected with difficulty, and there is great danger of including the descendens noni and cardiac nerves in the thread. I am confident that most of the difficulty and embarrassment often experienced in this operation and others on the large vessels, usually arises from not properly opening the sheath. The artery is now exposed, and may have the ligature cast around it by one of the instruments already named. In using the aneurism needle, great care must be taken to avoid including the par vagum, or inflicting injury on the vein. We are directed to introduce the point of the instrument on the outside, between the artery and the vein; but I am persuaded that this, although universal, is an erroneous practice. When the blunt needle is thrust between the artery and vein, and brought up on the inside of the artery, it is difficult to ascertain whether the instrument carries any thing before it, till it rises on the inside of the vessel. But if we introduce it on the inside, and bring it up between the artery and vein, we can, by applying the finger to the point, as it emerges, tell in a moment whether any thing but fascia intervenes between the finger and it. Besides, the par vagum, or the vein, will much more readily slip from, and evade the point of the instrument when lifted up on it, than when pressed

ascends obliquely toward the angle of the mouth, between the triangular and masseter muscles, being exceedingly tortuous, and covered by the skin and platysma. Near the edge of the upper lip, it insinuates itself beneath the blended insertions of the lavator and the depressor anguli oris, and passes upon the side of the nose, to the inner canthus of the eye, where it is lost by anastomosing with the nasal twig.

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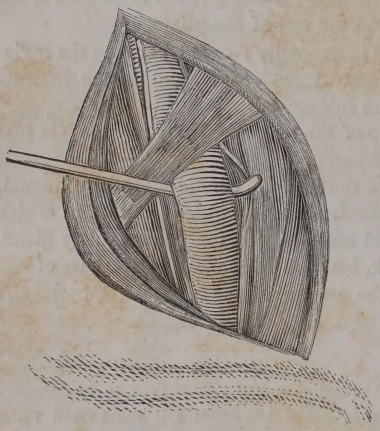
down by it upon subjacent parts. It is also more convenient to pass the needle beneath the artery on the inside, because the outside of the organ is here overlapped by the muscle. I have myself tested the two methods of passing the instrument on the living subject. In tying the carotid on a patient in the Baltimore Infirmary, November, 1828, I first attempted to pass the needle from the outside, but finding it inconvenient, instantly reversed it, and passed it from within outward with the greatest facility.



The accompanying cut represents the method of exposing the carotid for the ligature, in the situation described. The needle is here conveyed from without inward. The artery is raised upon the needle. The omo-hyoid muscle is seen crossing the artery obliquely. On the posterior and outer side of the artery the par vagum is seen descending, and, in front of this, coming obliquely from the anterior face of the artery—the descendens noni. Exterior to both the nerves, is the vein.

If it be necessary to secure the artery still lower, where it is covered by the coincident edges of the sterno-mastoid, thyroid and hyoid, these must be forcibly distracted; or, to render the organ more accessible, some of their fasciculi may be divided. The spasmodic contraction of the sterno-mastoid and the other muscles, causes them to spring up in such a manner that the artery appears much deeper than in the dead subject, and lodged in a kind of axillary cavity.

In securing the artery above the omo-hyoid, the surgeon makes his incision, two inches in length, just inside of the line which indicates the course of the artery from the angle of the muscles to the angle of the jaw, and parallel with it. The incision terminates just below the omo-hyoid. The cut is deepened a little obliquely outward, in order to leave the vein still bound, in some degree, by the skin, fascia, and sheath, that, as it alternately expands and collapses during the irregular breathing and struggles of the patient, it may not throw itself in front of the artery, a circumstance dwelt upon with much emphasis by Sir A. Cooper, and one of by no means trivial importance. I have myself experienced much annoyance in performing this operation, from the presence of the vein. This difficulty is much more important above the omo-hyoid than below it, for there are there small veins which cross the upper part of the carotid, from the throat to the jugular, or its branches, and which thus bind the artery to the vein. If we make our incision too high, these veins are apt to be wounded, and to cause an annoying hemorrhage. There is another danger from this error; the surgeon may encounter the external or internal carotid, instead of the common carotid. To this I should attach less importance did I not know that an operator had committed this error. We should also avoid making our incision too far within the line of the artery, lest we wound the thyroid artery, a portion of which is nearly parallel with the carotid. My distinguished colleague, the late Professor Davidge, informed me that he once witnessed an operation for securing the carotid, in which the thyroid artery was first cut, and then the ligature applied, by mistake, to the internal carotid, instead of the common carotid. This complicated mischief occurred from the incision being made too high.

In one instance I witnessed great embarrassment in the execution of this operation from the presence of the *anterior* jugular vein. This vessel (not usually existing,) is sometimes found extending along the border of the sterno-cleido-mastoid muscle. In the instance alluded to, the operator, encountering a large vein after dividing the skin and a considerable volume of fatty substance, presumed that he had reached the internal jugular, and of course was much perplexed at not finding the artery in close connection. The error being discovered, the vein was easily turned aside, and the artery exposed by a deeper incision.

of the ophthalmic artery, or the infra-orbitar. Where the facial artery is wrapped around the edge of the jaw near its angle, it is very superficial, and can be distinctly felt. Above, it lies over the buccinator muscle, embedded in much adipose tissue, crosses the border of the orbicularis oris, the levator of the lip, and the levator of the lip and nose. The facial artery in its ascent throws off frequent branches

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EXTERNAL CAROTID AND BRANCHES.

It should be borne in mind that the Sterno-mastoid artery sometimes arises from the common carotid, and turning outward, crosses its parent trunk obliquely, and may be endangered. Aware of this the surgeon may always avoid it.

The symptoms of aneurism of the carotid are those which characterize aneurisms generally.

External Carotid. The local relations of this artery to the digastric and stylo-hyoid muscles, the lingual nerve, parotid gland, &c. I have already given. At its origin it is invested by the same coverings that belong to the common carotid, also by veins, which cross it from within to join the jugular, and by venæ comites, one upon each side. When wounds have been inflicted upon the inaccessible branches of this artery, within the parotid gland, or when vascular sarcoma is fed by them, the ligature of the external carotid is undoubtedly to be preferred to that of the common carotid. If the common carotid be secured, under these circumstances, blood will regurgitate through the internal carotid, and through the superior thyroid. The ligature should be applied above the thyroid, lest from its proximity to the common carotid, secondary bleeding should result.

This can be accomplished with facility below where it passes under the digastric muscle, by cutting as for the common carotid, and extending the incision toward the angle of the jaw, to a point opposite the os hyoides. The trunk of the common carotid guides the finger to the external, which is a little on the inside of the line of the former. Care must be taken to inflict no injury upon the thyroid, fascial, or lingual arteries, and the accompanying veins.

The artery may also, though with difficulty, be exposed above the digastric, by an incision from the lobe of the ear to the cornu of the os hyoides, which will expose the digastric and stylo-hyoid muscles. These are then to be strongly depressed, and the artery is seen merging itself beneath the parotid.

The external carotid, in consequence of its arching forward upon the side of the thyroid cartilage, is often wounded by suicides—far more frequently than the common carotid, in consequence of the backward inclination of the head and the usual obliquity of the incision.

The Superior Thyroid. This artery arching forward on the side of the larynx, is very much exposed to injury in the attempts of the suicide. If divided thus, the wound itself will sufficiently expose the artery to enable the surgeon to secure it. But if it be necessary to cut for and secure its trunk, an incision may be made through the integuments and fascia, from the side of the os hyoides, obliquely downward and outward, toward the mastoid muscle. It is surrounded by small veins, which may be pushed aside. It is recommended sometimes to secure this artery and its fellow for the cure of bronchocele by withholding blood from the tumour. The organ, in this disease, is generally enlarged.

The Lingual Artery—is not often wounded, or concerned in surgical operations. In some rare instances, it becomes necessary to cut for it, or the carotid, when the tongue has been deeply wounded, and hemorrhage cannot be controlled by ligatures applied to the bleeding portion, or by the actual cautery. To expose the trunk of the lingual, cut from the side of the os hyoides, outward, to the mastoid muscle. We thus expose the lower margin of the digastric, and the lingual nerve, below which is the artery, having the external carotid on its outside, partly covered by glands and small veins. The pharynx is within it, and the laryngeal nerve behind. It lies so deep, is so complicated in its relations and irregular in its origin, that it is better in such cases to secure the common, or external carotid. The ranine branch is sometimes carelessly cut in dividing the frænum. It, as well as the veins, may be avoided, by directing the scissors obliquely backward, and avoiding to cut deeply.

The Facial Artery—is but little exposed to injury where it retreats behind the digastric muscle, the gland, and the jaw. It is sometimes sacrificed in removing the gland, and tied near its origin. It might be secured under the digastric muscle, by making the incision practised in securing the lingual, and pressing upward the muscle. On the face, the artery is much exposed, and often concerned in surgical operations. It is very tortuous, loosely involved in cellular tissue, and superficial for nearly its whole extent. Where it crosses the margin of the jaw, it is distinctly felt at the margin of the masseter, covered by the platysma and skin. It is exposed here with great ease by an incision parallel with its course. Here, too, it may be effectually compressed upon the margin of the jaw. It may also be

to supply the numerous organs of the extensive region which it traverses. They are ten or more in number.

a. The *Inferior Palatine*—arises near the carotid. Its course is inward, upward, and backward, between the stylopharyngeus and glossus muscles, to which it gives branches; then its twigs pierce the superior constrictor, and supply the mucous lining of the pharynx, the velum pelati, and the tonsils.

b. The *Tonsillar*—inconstant, being often a branch of the preceding; when not, it arises above it—ascends between the pterygoid and stylo-glos. muscles, giving them twigs, and then entering the tonsil to anastomose with the pharyngeal and the internal maxillary.

ccc. The *Glandular*—are three or four small branches which pierce the gland, sending a twig to each glandula. They also send filaments to adjacent muscles and lymphatic glands.

d. The *Sub-mental*—arises from the facial as this leaves the gland, beneath the jaw. It runs along the inside of the margin of the bone, giving branches to neighbouring glands and muscles, and to the integuments. It winds along the surface of the mylo-hyoid muscle till it reaches the anterior insertion of the digastric, when it divides into several branches, which are distributed in a variable manner to the adjacent muscles, glands, and integuments, some of them rising upon the chin. Several small glands lie along the whole course of this artery, and receive filaments from it.

e. The *Inferior Labial*, regarded by Cloquet as the *anterior muscular*, is often a branch of the inferior coronary. Generally it arises from the facial just above the margin of the jaw, and is appropriated to the muscles and integuments of the lower lip, anastomosing with the dental and sub-mental.

f. The *Inferior Coronary*, a more important branch, is given off higher than the last. It insinuates itself beneath the depressor ang. or. and reaches the angle of the mouth, at the insertion of the zygomatic. maj. muscle. It gives branches to these muscles, and then conceals itself beneath the orbicularis oris—runs along the border of the lip, buried in its dense tissue, sending many branches to its vascular mucous lining, and meets its fellow. It inosculates with the labial and dental. The numerous labial glands are fed by this artery.

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exposed an inch from the commissure of the lips, by an oblique incision—or still higher, by an incision parallel with the anterior border of the levator labii.

Hemorrhage from the *Submental branch* may be commanded by pressure beneath the jaw, directed obliquely upward and outward. The *Coronary branches* are wounded in extirpating cancer of the lip and in the operation for hare-lip. They throw out blood rapidly, and, as they cannot retract freely in the firm substance of the lip, they generally require the thread. But as we are obliged to use sutures in such cases, for re-union of the lip, we can generally so manage them as to effect both objects at the same time. This we do by passing our sutures entirely through the lip, near its border, opposite to the artery, and thus compressing it. The artery is so near the mucous lining of the lip that in the living subject we can feel it beat.

The little branch which runs up on the side of the nose, when punctured, as I have witnessed, bleeds obstinately. This is because it is bound down by the firm fascia of the nose, and cannot well retract far. It retreats a little beneath this membrane, and cannot easily be found. The wound should then be dilated obliquely outward and downward. I have known it to bleed for two hours, *per saltum*, although strong pressure had been made upon it.

The Occipital Artery—does not appear to be much exposed near its origin, being so deeply buried by the mastoid and digastric muscles. I have, however, recently seen it cut, together with the mastoid, in an attempt at suicide. If it were necessary to secure it near its origin, it might be exposed by making an incision into the angle between the digastric and the mastoid muscles, where it will be found running along the border of the former, in company with the hypoglossal nerve. Where it emerges from beneath the splenius muscle, on the back of the head, it can be distinctly felt, as it divides into its numerous branches. Here it is often wounded by blows or falls that lacerate the scalp. It is then apt to bleed seriously, as it cannot retract far, because of the firmness of the scalp. Often compression upon the bone will command it; but the ligature is more safe.

Pl. 3.

gg. As the Labial Artery ascends, it gives off the *external muscular branches* of Cloquet. But the principal of these is often termed the masseteric, appropriated to the masseter muscle and the buccinator.

h. The *Superior Coronary*—arises nearly opposite to the angle of the mouth, passes obliquely and very tortuously upward, beneath the zygomatic muscles—then runs along the border of the lip to meet its fellow. It gives twigs to the levator muscles of the lip, to the mucous lining of the organ, to adjacent glands, and to the muscular and fatty substance of the lip.

i. The *Lateral Nasal*—variable and inconstant—arises on the levator of the lip and nose, and is appropriated to the side of the nose.

j. The *Angularis*—is the terminal branch, which inosculates with the ophthalmic. It runs up between the two origins of the levator of the lip and nose—giving branches to the cheek, eyelids and lachrymal sack.

Often, nearly opposite the facial artery, but sometimes as low as the division of the carotid, or lower, and sometimes from the thyroid or occipital, there is given off a branch termed the *Sterno-mastoid*. It is appropriated to the muscle of that name, and is sent to it in an outward and downward direction. A considerable branch accompanies the spinal accessory nerve, through the muscle, and anastomoses with cervical branches of the subclavian—also with others of the occipital, thyroid, &c. It sends branches to the deep muscles of the neck.

The *Occipital Artery* (Arteria Occipitalis,)—arises next in order, from the posterior part of the external carotid, just beneath the inferior portion of the parotid gland. It passes upward and backward, beneath the sterno-mastoid muscle, along the posterior digastric and the hypo-glossal nerve, crossing the internal carotid, jugular vein, par-vagum and spinal accessory nerves. Then it proceeds horizontally, between the transverse process of the atlas and the mastoid process. It turns back upon the occipital bone, passes along beneath the splenius muscle, and issues from under its inner edge to become superficial, and to distribute its tortuous branches upon the back of the head.

In its deep course, this artery gives branches to the digastric, sterno-mastoid, and stylo-hyoid muscles. One branch of considerable magnitude, termed the *posterior mastoid*, enters the skull by the mastoid foramen, and becomes the posterior meningeal artery. Other branches nourish the splenius and complexus muscles, and, dipping beneath them, inosculate with branches of the vertebral.

Where the occipital becomes more superficial, on the back of the head, it sends several twigs downward to the muscles of the back of the neck and back, but larger and more numerous branches upward, which meander in the dense tissue of the scalp and the occipito-frontal-muscle, inosculating with the opposite occipital, with the auricular, and with the temporal. Sometimes it sends a ramulus through the parietal hole to the dura mater.

INDEX TO PLATE III.—Fig. 1 marks the Sternum; 2, origin of Pect. muscle; 3, Sterno-mastoid; 4, Clavicle; 5, 1st Rib; 6, Subclavius m.; 7, Pect. Min.; 8, 9, Serratus; 10, 10, Latissimus D. and Teres maj.; 11, Coraco-brachial; 12, Pect. maj.; 13, Deltoid; 14, Biceps; 15, Triceps; 16, Axillary space; 17, Trapezius; 18, 20, Levator Scapulæ; 19, Splenius; 21, post. Scalenus; 22, ant-Scal.; 23, 24, Constrict. infer. Pharyn.; 25, Thyro-hyoid M.; 26, Thyr. Cartilage; 27, 28, Insertion of Sterno-hyoid and Omo-hyoid m.; 29, 30, Hyo-glos. divided; 31, Stylo-glos.; 32, anter. Digastric; 33, Mylo-hyoid; 34, 35, Depressor ang. or.; 36, Masseter; 37, Occiput; 38, Sterno-mastoid; 39, Thyr. Gland; 40, Trachea; 41, Axillary Gland; 42, Subclavian Art.; 43, common origin of the Infer. Thyr. and Ascend. Cervical; 44, Thyroid; 45, Vertebral; 46, Superficial Cervical, here a branch of the Ascend. Cervical; 47, Superior Scapular; 48, Internal Mammary; 49, Transversalis Colli; 50, Superior Thoracic; 51, 2, 3, Acromialis; 54, Thoracica Longa; 55, 6, 7, Sub-scapular, and branches; 58, Posterior Circumflex; 59, branch to the Coraco-Brach.; 60, Anter. Circumflex; 61, the C. Carotid A.; 62, In. Carotid; 63, Ex. Carotid; 64, Thyroid; 65, Lingual; 66, Facial; 67, Sub-mental; 68, Masseteric; 69, Infer. Coronary and Labial; 70, Dental; 71, Facial continued; 72, Duct of Steno; 73, the Sterno-mastoid; 74, Occipital; 75, Pharyngeal; 76, Auricular; 77, trunk of Temporal and Maxillary; 78, Transversalis Faciei; 79, Anter. Temporal; 80, 1, 2, 3, continuation and branches of the Occipital.

The *Posterior Auricular* (Arteria Posterior Auris)—one of the smallest and most irregular branches, sometimes comes from the occipital. Generally it springs from the external carotid above the digastric and stylo-hyoid muscles, within the parotid gland, opposite the point of the styloid process. It runs upward and backward, between the ear and the mastoid process, and ascending on the temporal bone, divides into two branches. The anterior ramifies on the cartilage of the ear—the posterior ascends on the side of the cranium, supplying the integuments and part of the temporal muscle. In its ascent the trunk of the auricular gives branches to the neighbouring muscles. As it approaches the mastoid process, it lies behind the portio dura and separates it from the spinal accessory. Here the artery sends off a minute twig, which enters the stylo-mastoid foramen, supplying the tympanum, mastoid cells, and semi-circular canals, and anastomosing with other arteries of this region.

The *Pharyngeal* (Arteria Pharyngea Ascendens)—arises from the posterior part of the external carotid, opposite the facial. It ascends along the lateral and back part of the pharynx, between the external and internal carotids, covered by the stylo-pharyngeus muscle, and the constrictor superior. After a short course, in which it gives twigs to adjacent muscles, it is resolved into two branches of equal size. The first of them, the proper *Pharyngeal* branch, lying transversely on the superior constrictor, divides into two or three ramuscles, one of which is appropriated to the last named muscle, and the others pass downward to the inferior constrictors. The second, or *Meningeal* branch, passes up between the internal carotid, the pneumo-gastric nerve, and the internal jugular vein, giving twigs to the superior cervical ganglion, the Eustachian tube, the recti, and the longus colli muscles, and finally penetrates the skull by the posterior foramen lacerum, to ramify on the dura mater. Another twig enters by the anterior foramen lacerum, and a third, by the anterior condyloid.

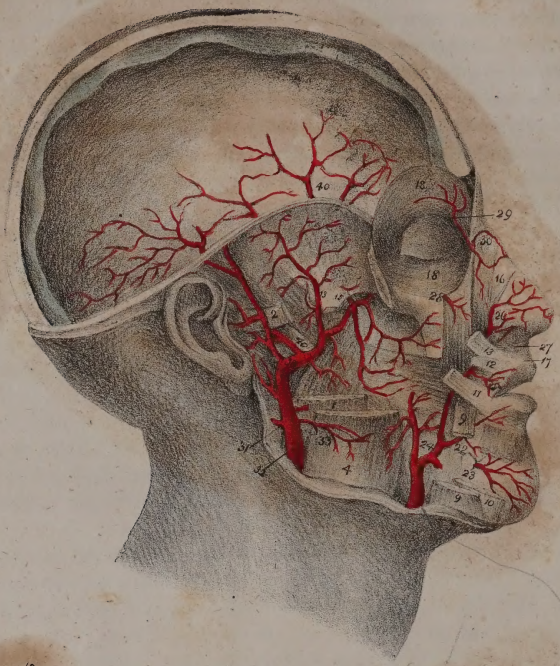
The *Temporal* (Arteria Temporalis)—is one of the two branches into which the external carotid is resolved, midway between the angle and condyle of the lower jaw. It is smaller than the internal maxillary, but is more directly continuous with the parent trunk. Its origin is involved in the parotid gland, from beneath which it emerges as it ascends between the meatus of the ear and the articulation of the jaw. It then crosses the root of the zygoma beneath the anterior muscle of the ear, and, an inch and a half above it, divides into *anterior* and *posterior* branches. Just above the zygoma, the artery is often covered by two or three veins, and is accompanied by branches of the portio dura nerve. Above, the artery is covered merely by common integuments.

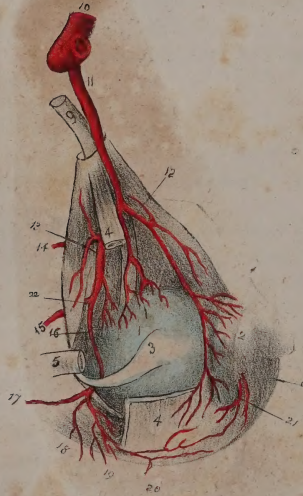
SURGICAL OBSERVATIONS.

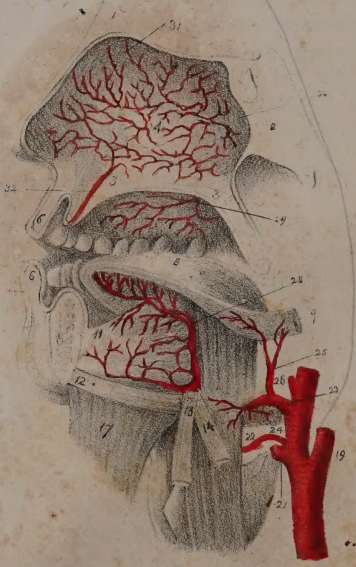
The Posterior Auris. It is never necessary to secure this artery, unless it be wounded, which, however, very rarely occurs.

The Ascending Pharyngeal. This is an artery of inconsiderable magnitude. It lies so deeply buried among other important organs, that a wound which might reach it, would inflict far more important—probably fatal injury upon them. Nor if the artery were alone injured, could it be reached with the knife without causing still more serious mischief.

The Temporal. In its surgical relations this is one of the most important arteries about the head. In the first part of its course, it lies deeply buried in the substance of the parotid gland. There it is never approached with the surgeon's knife, unless for the purpose of extirpating the gland. It must then necessarily be sacrificed, together with the other branches which spring from the external carotid within the gland. It is certainly matter of surprise, that an organ involving so many important arteries, should have been so often extirpated, as undoubtedly it has been by Mr. Goodlad, Mr. Carmichael, and many others, and in several instances with but little bleeding. Many scientific anatomists still deny the possibility of this operation, it being easier for them to believe that surgeons have been deceived, or have reported incorrectly, than that an achievement, apparently so impossible, has been accomplished. I entertained this opinion myself, till at length I saw the gland completely extirpated, and that with but little hemorrhage. I account for this opposition of opinion and fact, on the presumption that, as the diseased parotid becomes indurated and enlarged, it recedes from its deep situation, dragging with it these arteries, pressing upon them and effecting their obliteration. In the instance to which I allude, there was bleeding but from one branch—the temporal, and that in the retrograde direction.







Drawn on Stone by S. Smith

Fig 3

Fig 2

Geo. Willag.e Lith.

The branches of the Temporal are, first, the *Anterior*, given off near its origin and appropriated to the anterior muscles and to the maxillary articulation. The most remarkable of them is the Transverse Facial (Transversalis Faciei) which Mr. Harrison describes as a branch of the external carotid. It crosses the neck of the condyle, gives a twig to the masseter, and there anastomoses with the internal maxillary. Then, beneath Steno's duct, it crosses the muscle and terminates at its anterior margin. It gives twigs to the parotid gland, many to the duct, the muscles and integuments; also to the zygomatic and orbicular muscles. Others anastomose with those of the facial, buccal, and infra-orbitar.

Next, are the *Anterior Auricular*, variable in number and size, distributed to the meatus and auricle of the ear; then the *Middle Temporal* coming off above the zygoma. This perforates the aponeurosis of the temporal muscle, to which it is then appropriated by many branches, some of which communicate with the deep temporal.

The *anterior* of the two branches, into which the Temporal is finally resolved, passes upward and forward, in a very tortuous course to the lateral part of the forehead. It is there divided into a great number of ramuli which, in every direction, are appropriated to the frontal and orbicular muscles and to the integuments. Some of these anastomose with the frontal and superciliary artery, others, with those of the opposite side.

The *posterior* ascends tortuously and obliquely, over the parietal and occipital bones, giving twigs to the integuments, the aponeurosis of the temporal muscle, the attollens aurem, and pericranium. It anastomoses with the anterior branch of the opposite temporal, and with the occipital and posterior auricular.

The *Internal Maxillary*, (Arteria Maxillaris Interna,) is one of the largest branches of the external carotid. From the point of its origin already named, this artery abruptly diverges from the temporal, and passes inward and a little downward, almost at right angles with the ramus of the jaw, and between it and

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INDEX TO PLATE IV.—Fig. 1 represents the ramifications of the Internal Maxillary, as well as other arteries of the head and face, and their relative anatomy. No. 1, Ramus of the Jaw divided; 2, 2, sections of the Zygoma; 3, Styloid Process; 4, Masseter muscle; 5, Temporal m.; 6, External Pterygoid m.; 7, Inter. Pter. m.; 8, Buccinator m.; 9, 9, Depressor of the angle of the mouth; 10, Depressor of the lower lip; 11, 12, portions of the Zygomatic m.; 13, Levator of the angle of the mouth; 14, Levator of the upper lip; 15, Levator of the lip and nose; 16, Compressor of the nose; 17, Orbicularis oris; 18, Orbic. Palpebrarum; 19, Parotid Duct; 20, Labial artery; 21, branch of same; 22, Inferior Coronary; 23, Mental branch of the Dental; 24, trunk of the Labial; 25, Superior Coronary; 26, Lateral Nasal a.; 27, branch to the nares; 28, Sub-orbitar a.; 29, branch of the Frontal; 30, branch to the Dorsum of the nose; 31, Internal Carotid; 32, External Carotid; 33, Masseteric branch; 34, Posterior Auricular; 35, deep branch to the ear; 36, branch to the Parotid; 37, superficial Temporal, and below this, the Transversalis Faciei; 38, *In Maxillary;* 39, branch to the Internal Pterygoid m.; 40, middle Meningeal; 41, branch to the Tympanum; 42, Inferior Dental; 43, deep Temporal; 44, branch to the Internal Pterygoid; 45, anterior deep Temporal; 46, Buccal; 47, branch of the last to the Masseter m.; 48, superior Palatine; 49, Alveolar; 50, Sub-Orbitar; 51, posterior Nasal.

Fig. 2 represents the ramifications of the Lingual Artery and some of the branches of the Nasal. No. 1, marks the frontal sinus; 2, section of the Sphenoid bone; 3, section of the Palate; 4, septum narium; 5, 6, section of the jaw and lips; 7, Palate; 8, Tongue; 9, Stylo-glossus m.; 10, Hyo-glos. m.; 11, Genio-hyo-glos. m.; 12, Genio-hyoid. m.; 13, 14, Sterno and omo-hyoideus; 15, Thyro-hyoideus; 16, Thyroid c.; 17, Thyro-hyoid. m.; 18, *Common Carotid A.;* 19, Inter. C.; 20, Exter. C.; 21, inf. Thyroid; 22, Laryngeal; 23, *Lingual;* 24, branch to hyoid muscles; 25, Dorsalis l.; 26, Facial; 27, Ranine; 28, Sub-lingual; 29, superior Palatine branch of the I. M.; 30, posterior Nasal; 31, Ethmoidal; 32, branch of post. nasal, to foramen incisivum.

Fig. 3 represents the branches of the Ophthalmic and their anatomical relations. No. 1, Globe of the eye, 2, Lachrymal Gland; 3, Tendon of the sup. oblique m.; 4, Levator palpebræ; 5, Pully; 6, Orbicularis; 7, Adductor m.; 8, belly of the oblique m.; 9, 9, Optic Nerve; 10, *Inter. Carotid a.;* 11, *Ophthalmic a.;* 12, Lachrymal; 13, Opthalmic continued; 14, posterior Ethmoidal; 15, ant. E.; 16, Oph. continued; 17, Frontal; 18, 19, branches to the canthus, nose, and to lower eye-lid; 20, Palpebral branch; 21, Palpebral branch of the lachrymal; 22, Ciliary arteries.

its internal lateral ligament. Then it passes more directly inward, and describing an extremely tortuous course, it winds its way through a space, above which is situated the external pterygoid muscle;—below, the in. ptery. musc.—internally, the buccinator;—externally, the ramus of the jaw and the insertion of the temporal muscle. The artery then mounts over the ex. ptery. musc. and insinuates itself between this last and the temporal; finally, it winds in a very capricious manner, downward, forward, and inward, between the two origins of the ex. ptery. into the pterygo-maxillary fossa.

At its origin this artery is completely involved in the parotid gland; indeed, as is stated by Mr. Harrison, "a process of the gland is seen to pass inside of the ramus of the jaw," accompanying this artery and its associated vein, between the bone and ligament, so as to touch the inferior maxillary nerve.

The Internal Maxillary is remarkable for the number of its branches and the intricacy of their distribution. It is the deep artery of the face, the basis of which is an exceedingly irregular pile of bones, perforated by numerous foramina, through which the branches of this artery insinuate themselves, and pass to organs difficult of access. Cloquet describes thirteen branches of the Internal Maxillary. He divides them into three orders, but I discover no utility in such a division.*

SURGICAL OBSERVATIONS.

When the Temporal Artery is wounded in the gland, the external carotid must be secured. If it be wounded just above the zygoma, or on it, it is to be remembered that the artery is there invested with a fascia, beneath which it may retreat. To reach it, this must be divided in the direction of the artery. Here it is not safe to trust to compression, because of the presence of the temporal muscle beneath the artery. The external effusion may be suppressed, but blood will be thrown beneath the fascia and occasion much mischief. On this portion of the artery, arteriotomy should never be performed. The part selected for this operation, is the anterior branch, on the side of the forehead, two inches or more from the zygoma.

The branches of the Temporal, on the side of the head, are often wounded, and bleed obstinately, because they cannot retract with facility. But fortunately they are more easily commanded by compression than any other arteries of the human body.

The Transversalis Faciei is sometimes wounded on the face. If it be necessary to secure it toward its origin, it may be found by making an incision just above the course of the Parotid Duct. It is there bound down by a fascia.

Internal Maxillary Artery. This vessel lies so deeply buried in the zygomatic fossa—is so safely protected by its bony defences, and by the firm substance of the parotid gland, in which it is involved, that very rarely is it the seat of traumatic hemorrhage. An acute instrument only can reach and wound it, unless, indeed, organs be wounded which are essential to life. But even were the vessel wounded and requiring the ligature, the most minute acquaintance with its anatomical relations, would not enable the surgeon to expose and secure it at the place of injury. If compression failed to arrest the bleeding, the prudent surgeon would seek, at once, the external or common carotid.

Mr. Harrison, in his surgical remarks upon this artery, describes very particularly the relations of the parotid gland to it, and to other adjacent organs. To remove this organ completely without a fatal result, appears to him to be an impossible achievement. He, as well as surgeons generally, appears to take it for granted, that disease of the organ must necessarily complicate the difficulty. There are diseases, it is true, which are readily imparted from one tissue to another, and which promptly involve adjacent organs; but there are others which, when they seize upon an organ of such peculiar texture as that of the parotid gland, are insulated in it, and reluctant to pass beyond it. The disease goes on to occupy the whole substance of the gland, while nature throws over it an investment of lymph. The organ becomes more spherical in form, retreats from its deep connexions, and withdraws its processes, because the mastoid process behind, and the jaw in front, are constantly urging it outward. In the mean time, the arteries involved by it, are either obliterated by pressure, the circulation being compelled to seek another route, or the coats of the artery, being completely

* To obtain a view of the devious windings and complex divisions of this artery, let the student divide the head vertically, a little on one side of the septum narium—then the zygoma, near its root, also the malar bone, where it joins the frontal, and where it joins the sup. max. Then raise the arch. The half of the lower jaw is to be pulled outward—the coronoid process cut and removed, and the adipose substance taken away.

a. The *Middle Artery of the Dura Mater*, (Arteria Meningea Media,) is the first in order and in magnitude. It springs from the superior part of the artery, on the inside of the neck of the jaw—thence it ascends toward the base of the cranium, between the ptery. muscles, and between the lateral ligament and tensor palati muscle, imparting irregular branches to these and other contiguous organs. It is here accompanied by two filaments of the infer. max. nerve, which pass to unite with the facial nerve. Before it leaves this region, it sends small twigs to the Eustachian tube, some of which perforate the tympanum and supply its muscles; others which pierce the sphenoid bone, and reach the dura mater. Then the artery enters the foramen spinale of the sphenoid bone, to be appropriated to the interior of the cranium, and insinuating itself under the dura mater, immediately commences to give branches to that portion of the membrane which lines the middle fossa of the cranium, and to the fifth pair of nerves. Two or three of these enter the orbit and pass to the lachrymal gland; one enters the aqueduct of Fallopius; another, the canal of the inter. muscle of the malleus, sending filaments to the walls of the tympanum.

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enveloped in the disease, participate in the disorganization of the gland, and cease to perform their functions. We well know that arteries, even larger than any of those involved in the parotid gland, are often, by the invasion of adjacent tumours, completely obliterated.

It should be observed that the testimony which is adduced against the practicability of extirpating the parotid is of a negative character, and therefore of far less value than the positive averment of respectable authorities, who declare that they have witnessed, or performed the operation.

Middle Artery of the Dura Mater. This is almost the only branch of the internal maxillary which is liable to be at all concerned in surgical operations, or to be the seat of troublesome traumatic hemorrhage. The anterior branch, as it ascends on the anterior angle of parietal bone, stands out in bold relief from the dura mater, and always deeply furrows the bone—sometimes occupying, for a short distance, a complete canal in it. Here the artery would of course be much more liable to injury, from fracture or the trephine, than at any higher point on the head. Fortunately, however, this region of the cranium is but little exposed, both on account of its sheltered position, and because it is protected by the thick cushion of the temporal muscle.

But as the artery ascends along the internal surface of the walls of the cranium, it recedes a little from its hollow in the bone, and sinks in an equal degree into the dura mater. It then becomes, indeed, intimately incorporated with the fibrous tissue of that membrane, a lamina of it passing over the artery and binding it down, so that it is impossible to raise the artery without lacerating this portion of the dura mater. It is with no small surprise that I read the following observation on this subject, in Mr. Robert Harrison's Surgical Anatomy of the Arteries, (vol. 1. p. 74.) "Although this artery is commonly called the middle artery of the dura mater, yet it appears at least equally destined to be a nutritious vessel to the bones of the cranium, for it lies external to the dura mater, and not between its laminæ."

Fortunately I had an opportunity, a few days since, to test the correctness of this observation, on the living subject. In consultation with Dr. Thomas H. Wright, of this city, (Aug. 22d,) I witnessed a case of fracture of the os parietale, in which, the bone being somewhat comminuted, and the tables cleft asunder, the branches of this artery were slightly wounded by the serrated edges of the fragments. Dr. Wright and myself advised that the triphine should be applied, both for the purpose of exposing the bleeding vessel, and removing the loose fragments which were locked. This was done with the expectation, on my part, that it might be necessary to use the ligature for the suppression of the very copious hemorrhage which existed.

On the removal of the bone, the bleeding vessels were readily found, their pulsation being evident, and the blood seen to circulate through their transparent walls. They were no where torn across, but only slightly wounded, at different points. It was perfectly obvious to the eye (more so than it could have been on the dead subject, because the artery was full) that these vessels were involved in the laminæ of the dura mater. The shining fibres of the membrane, indeed, could be seen to pass over them. The point of a probe was passed over them repeatedly, and it was impossible to engage it beneath the arteries without lacerating the dura mater. The bleeding was suppressed with a dossil of lint, and the patient did well.

The artery is now resolved into two unequal branches. The anterior, the larger, inclines forward, and ascends to the anterior and inferior parietal bone, burying itself in a deep groove of the bone—often in a complete canal. Here it gives off a few twigs to anastomose with branches of the ophthalmic, and then ascends along the internal surface of the parietal bone, being subdivided into numerous irregular branches meandering beautifully over the whole surface of the bone, and impressing their dendriform traces upon it. Numerous terminal twigs ascend as high as the superior longitudinal sinus, anastomosing with each other and with twigs of the opposite side. The arteries themselves resemble small tubes buried in the dura mater itself and incorporated with its tissue. They are proper to this membrane, merely sending off a few twigs to anastomose with those of the pericranium, and those chiefly opposite to the sinuses.

The posterior branch bends backward, as it ascends on the squamous expansion of the temporal bone and on the parietal. It is resolved, in a very inconstant order, over the lateral and posterior parts of the dura mater, into numerous twigs, which frequently anastomose with each other, and make their impressions on the bone. The walls of this artery are exceedingly thin, the middle coat being scarcely discernable. Its place seems to be supplied by the envelope which the organ receives in a part of its course from the dura mater.

b. The *Inferior Dental, or Maxillary Artery*, (Arteria Dentalis Inferior,) arises opposite to the origin of the meningeal. It passes forward and downward, along the inside of the ramus of the jaw, on the outside of the ptery. in. musc. behind the inferior dental nerve, and before the internal lateral ligament, to the canal which commences on the inside of the jaw, at the root of the coronoid process, and which opens on the chin at the mental foramen. The artery traverses this canal, but before it is merged in it, it gives off branches to neighbouring muscles and nerves—also one which runs upon the inside of the jaw along the attachment of the mylo-hyoid muscle, often making, at its origin, an impression on the bone. This twig belongs to the last named muscle, and to the mucous membrane of the mouth.

When the artery has entered the canal, together with the dental nerve, it passes beneath the alveoli, giving off ascending twigs which enter those sockets, to seek and enter little foramina which are seen in the extremities of the fangs of the teeth. It is resolved into two branches, opposite to the first bicuspid tooth; one branch emerges from the mental foramen, supplying adjacent muscles and anastomosing with facial twigs. The other larger and continuous branch keeps its direct route, and reaches the symphisis of the chin, giving twigs to the roots of the remaining teeth.

Cloquet remarks that, at the origin of the dental artery, the internal maxillary gives off twigs, one of

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SURGICAL OBSERVATIONS.

It is equally matter of surprise that Mr. Harrison declares the dura mater to have "a much more vascular connexion with the internal surface of the bones of the cranium, than the pericranium has with the external." This is palpably erroneous, from the fact that the pericranium is a true periosteum, and entirely subservient to the circulation and organization of the bones of the cranium, whereas the dura mater is, at least in part, designed for other important purposes—for forming the sinuses, protecting the brain, and furnishing the partition walls of the cranium. Its nutrient offices to the cranium are merely adventitious, as ought to be obvious to any one who separates successively these two membranes from the bone. The pericranium he will find to be intimately incorporated with the bone, and that it is with difficulty scraped away; whereas the whole calvarium is pulled off from the dura mater at a single effort. Mr. Harrison appeals to the fact that the cranium more readily dies when the dura mater is detached, than when the pericranium is stripped away. But this is because blood accumulates beneath the bone, and inflicts injury upon it.

If this artery were wounded below where it merges itself in the dura mater, it might be safely secured with a ligature, though often compression would suffice, for the walls of the vessel are exceedingly thin. At a higher point, a ligature would be exceedingly improper.

The Dental Artery. This organ, in rare instances, is wounded in extracting the last molar tooth. The foramen, into which it enters, is only about half an inch distant from the crown of the tooth, and the canal along which it is transmitted is immediately below its roots. When the injury occurs, the coagulum should be carefully removed, and a conical

which ascends to the auditory canal and membrane of the tympanum, and another penetrates the tympanum by the glenoid fissure.

c. The *Posterior Deep Temporal Artery*, (Art. Temporalis Profunda,) arises a little beyond the preceding, but is sometimes a branch of it. First, it passes behind the temporal and ex. pterygoid muscle, then it ascends beneath the former organ, passes along the temporal fossa, dividing and subdividing, to supply the periosteum and tem. musc. These anastomose with the other temporal arteries.

d. The *Masseteric*, (Masseterica,) is smaller than the preceding—sometimes a branch of it. Emerging from between the posterior edge of the temporal muscles, and the neck of the jaw, it passes over the notch which separates this from the coronoid process. It then gives some small branches to the upper part of the masseter muscle, and, descending obliquely between the muscle and the ramus of the bone, is lost in the substance of the muscle, where it anastomoses with the transverse artery of the face.

e. e. e. The *Pterygoid Arteries*, (Arteriæ Pterygoidæ,) are a variable number of small twigs arising from the I. M. and appropriated to the pterygoid muscles. Their order of distribution is so inconstant, and their course so irregular, that they defy particular description.

f. The *Buccal Artery*, (Arteria Buccalis,) sometimes springs from the deep temporal, or alveolar, or even the infra-orbitar. In a very tortuous manner, it descends obliquely forward, together with the buccal nerve, insinuating itself between the ptery. inter. musc. and the jaw. Here it assumes a more transverse direction as it approaches the cheek, and a little way from the commissure of the lips, it is resolved into a great number of twigs, which are very irregularly distributed to all the organs which constitute the cheek. It there anastomoses with filaments of the facial, of the infra-orbitar, and transverse artery of the face. The B. A. is a more considerable vessel than either of the three preceding.

g. The *Anterior Deep Temporal Artery*, (Art. Temporalis Profunda Anterior,) arises from the in. max. in the zygomatic fossa. It ascends along the temporal fossa, between the internal and anterior part of the temporal muscle, and the spheroid and malar bones. One twig pierces the malar bone, enters the orbit and inosculates with an ophthalmic branch. Others also pierce the same bone, reaching some of the appendages of the eye. The artery terminates by subdivions in the temporal muscles.

h. The *Alveolar Artery*, (Maxillaris Superior,) also arises from the in. max. in the zygomatic fossa, opposite to the maxillary tuberosity, round which it winds in a serpentine course. As it passes forward, it sends branches to the posterior dental canals, for the fangs of the large molar teeth, and the mucous lining of the antrum. It then passes tortuously along the gums, giving twigs to them, till it reaches the fossa of the canine tooth. Here it sends twigs to the small molar teeth, and then subdivides indefinitely to supply the adjacent organs, and to anastomose with the infra-orbitar.

i. The *Infra-Orbitar*, (Arteria Infra-Orbitalis,) arises near the upper and fore part of the zygomatic fossa. At its very origin, it gives branches to the fat and periosteum of the orbit, and passing forward on the floor

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piece of sponge pressed into the wound and confined between the jaws. Should this fail, the actual cautery should be promptly resorted to, for this hemorrhage has, in one instance, proved fatal even after a ligature had been applied to the carotid of the injured side.*

In the Medico-Chirurgical Review, for June 1830, I find a letter addressed to the editor, by J. Lizars, of Edinburgh, on a method of dividing the submaxillary nerve, for neuralgia. In the operation which he advises, the dental artery is concerned. With a scalpel, he makes an incision within the mouth, to the extent of an inch, through the mucous membrane and cellular tissue connecting the pterygoideus internus muscle to the ramus of the bone, parallel and close to the inner, or mesial surface of the coronoid process, immediately behind the dens sapientiæ; then, with a round-shaped gum lancet carried backward in a line continuous with the crowns of the molar teeth, and having its cutting edge at right angles to the bone, he divides the nerve on the bone. The keen pain produced by its division announces that the proper

* Medico Chirurgical Transactions, vol. viii.

of the orbit, enters the infra-orbitar canal. It is lodged in the whole length of this canal, being associated with a nerve of the same name, which lies above it. Through the shell of bone which covers this canal, it sends upward twigs to the inferior and oblique muscles of the eye—to the lachrymal sac, and to the orbicular muscle. Near its place of exit, it gives a branch to the anterior dental canal, for the roots of the canine and incisor teeth, and for the membrane of the maxillary sinus. At length it emerges from the infra-orbitar foramen, behind the levator of the lip, and is immediately resolved into numerous terminal branches, which supply the muscles of the lip, and the nose, anastomosing with many of the arteries above described.

j. The *Vidian*, (Vidiana,) is a small branch which occasionally arises from the superior palatine; its origin is nearly opposite to that of the infra-orbitar, behind the orbit of the eye, in the spheno-maxillary fossa. It enters the pterygoid foramen of the sphenoid bone, and accompanies the vidian branch of the fifth pair of nerves through that canal. On issuing from it, the artery is resolved into branches, which are appropriated to the tube of Eustachius, and to the vault of the pharynx. It anastomoses with the inferior laryngeal. In its passage through the Pterygoid canal, it gives twigs to the cells of the sphenoid bone.

k. The *Pterygo Palatine*, (Arteria Pharyngea Superior,) is even smaller than the preceding, and arises near the same point. Its course is obliquely backward and upward, till it enters the pterygo-palatine canal; and then it proceeds backward to supply the upper walls of the pharynx. It also gives small twigs to the cells of the sphenoid; and to the tube of Eustachius.

l. The *Superior Palatine*, (Palatina Descendens.) This artery is of more considerable magnitude than the last described. It arises in the same region, and seeking the fissure between the pterygoid processes and the maxillary bone pursues it directly downward, till it enters the posterior palatine canal, giving off, as it approaches it, twigs which, passing through the bone, are distributed to the velum palati. The continued trunk, after issuing from the palatine foramen, passes forward between the bony palate and the firm membrane which invests it. It is lodged in a groove which is apparent in the bone, and which exhibits many flexuosities. Branches are given, in this course, to the mucous membrane of the palate; and one twig ascends to the nasal passages, by the anterior palatine hole.

m. The *Spheno-Palatine Artery*, (Spheno-Palatina,) is the terminal branch of the I. M. It seeks the spheno-palatine foramen, and by it enters the nasal cavity behind the posterior extremity of the superior meatus. It insinuates itself under the pituitary membrane, and immediately divides into two or three branches. One of these is appropriated to the septum of the nose. The others wind round the posterior part of the middle turbinated bone, and resolve themselves into branches which are appropriated to the nasal channels, the antrum highmorianum, and the ethmoid cells. These anastomose with the ethmoidal arteries, and form a close tissue of very supercial vessels, which give to the membrane the appearance of extreme vascularity.

The Internal Carotid Artery, (Arteria Carotis Interna.) This important vessel, as I have before stated, leaves the external carotid, the branches of which we have just described, at the lower margin of the

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organ has been cut. The dental artery is necessarily divided, but this Mr. Lizars regards as but of little moment. In the four cases in which he has performed the operation, he does not appear to have used any mechanical means to suppress hemorrhage. He remarks, however, that, were the artery morbidly enlarged, its bleeding would be easily restrained by a piece of dry sponge.

Hemorrhage of an obstinate character sometimes takes place after the extraction of a tooth; but I believe that it generally occurs from some vessel of the lacerated gum. The artery, though minute, does not always spontaneously cease to bleed, because it cannot retract into the firm substance of the gum, and because the coagulum is prevented from forming by the saliva. I have known such a hemorrhage to nearly prove fatal, in two instances. If the sponge does not promptly suppress it, the heated wire should be used.

Internal Carotid. In relation to the surgery of this artery, it is necessary to notice some of its connections more particularly. Near its origin, from the manner in which it arches outward, it becomes very superficial, being covered

digastric muscle. The internal carotid, near its origin, arches outward and forward, in such a manner that, at first, it appears often to be more external than that which is uniformly so called. Its flexuosities, however, vary. As it ascends from behind the digastric, it curves inward, and plunges between the ramus of the jaw and the pharynx. As it ascends, it still inclines a little inward, and lies in front of the vertebral column. At length, after a devious course, it finds the orifice of the carotid canal in the petrous portion of the temporal bone. In its ascent, it has the jugular vein on its outside and a little behind it; the pneumogastric nerve, and the superior cervical ganglion of the sympathetic, within. Together with these organs, it is involved in a loose common sheath of cellular tissue. This artery being designed for the interior of the cranium, gives off no branch before it enters the carotid canal.

In passing through the canal, its direction of course obeys the windings of that passage. First it ascends—then curves abruptly, to pass horizontally inward and a little forward—lastly, it again ascends, thus describing the figure of the italic S. In its transit through the bone, it is surrounded by a mesh of the primary filaments of the sympathetic nerve—branches of the fifth and sixth pairs, and is enveloped in the laminæ of the dura mater which lines the canal. While in the canal, it furnishes a branch which penetrates to the cavity of the tympanum, and is lost in the mucous membrane of the promontory—sometimes another, which enters the vidian canal.

As the artery issues from the internal orifice of the canal, and ascends into the cranium, it encounters the body of the sphenoid bone, and by it is reflected forward and downward, along its side, through the cavernous sinus, a thin membrane intervening between it and the blood of that cavity. Then it encounters the root of the great wing of the sphenoid bone, and is again made to curve abruptly upward and a little backward, beneath the anterior clinoid process. Thus, by this double curvature, it describes another figure like that of the roman S. In this part of its route, it gives minute twigs to the dura mater, the pituitary body, the sphenoid cells, and the common motor, pathetic, trifacial, and sixth nerves.

From beneath the anterior clinoid process, the internal carotid passes upward and a little backward, being still embraced by the dura mater, from which it escapes and becomes apparent in the cavity of the cranium, just behind and without the optic nerve. It is still enveloped in a process of the arachnoid membrane, and ascends obliquely backward and outward, and is resolved into branches at the fissure of Sylvius.

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only by the integuments and facia of the neck. Hence it has been encountered in cutting for the common carotid when the incision has been carried too high. As the artery ascends, it inclines inward and buries itself by passing beneath the lingual nerve—the digastric muscle—the external carotid, which it decussates above that muscle—the stylo-hyoid ligament, and the muscles which arise from the styloid process—the glosso-pharyngeal nerve. Lastly, it passes deeply behind and within the ramus of the jaw, and plunges beneath the parotid gland. The pharynx is closely connected to it on the inside. The tonsil is within, and anterior to the artery, united to it by loose tissue, but which, in case of imposthumes of this body, becomes so injected with lymph that the tonsil becomes fixed to the artery. Under such circumstances, an incautious thrust of an instrument into the tumour might endanger the artery, particularly as its flexuosities here are not very uniform. Sometimes the branches of the external carotid approach the tonsil very closely. The excision of this body has sometimes been followed by copious and alarming arterial hemorrhage—probably from the wounding of some devious branch, or perhaps from dragging the tonsil out of its fossa, and cutting its base too deeply. I am satisfied that it is never necessary to extirpate the entire body. In several instances I have cut away one half of the enlarged organ, and have found that the suppuration which followed, and the gathering of the cicatrix, dissipated the morbid enlargement.

It is obvious that the internal carotid might be wounded externally, near its origin, and other important organs escape. In such a case, if the wound did not expose the vessel, it might be found by extending upward the incision which exposes the common carotid, as high as the digastric muscle. Higher than this, the artery could hardly be wounded without complicated mischief being inflicted upon other important parts. In such a case the wound itself should be carefully searched for the bleeding vessels, in order that they may be secured both above and below the place of

While it is passing, as above described, along the clinoid process, it gives off its first important branch, the ophthalmic artery.

The *Ophthalmic Artery*, (Arteria Ophthalmica.) This artery immediately enters a small canal in the dura mater. Above and on the outside of the optic nerve, it passes, together with that organ, through the optic foramen to the orbit of the eye, insinuating itself between the motor nerve and the rectus internus muscle. It passes upward, on the outside of the optic nerve, and bending spirally over it, crosses to the inside, passing beneath the superior straight muscle of the eye. Here it again passes forward, between the obliquus superior and the rectus internus, to the inner angle of the orbit, where it is resolved into two branches. The branches into which the ophthalmic is resolved being very numerous, for the sake of perspicuity, they are divided into several classes. 1. Branches which arise from the ophthalmic artery, before it ascends upon the optic nerve. 2. Branches which arise from the ophthalmic artery during its passage over the nerve. 3. Branches which arise from the ophthalmic artery as it passes along the inner side of the optic nerve. 4. Branches in which the ophthalmic artery terminates.

1. *Branches which the Ophthalmic Artery gives off before it ascends upon the Optic Nerve.*

a. The *Lachrymal Artery*, (Arteria Lachrymalis,) is a very conspicuous branch of the ophthalmic, leaving it just as that vessel enters the orbit, and in a sinuous course passing forward to the lachrymal gland, between the abductor oculi, and the outer walls of the orbit. To the muscle just named it gives twigs—others to the recti superior and inferior—the levator palpebræ, the periosteum of the orbit, and the membranes investing the nerve. Near the gland it gives inconstant twigs to neighbouring muscles, and one small branch, which, passing backward and outward, divides and sends one twig to the orbit, and another through the malar bone to the temporal fossa, where it anastomoses with the deep ant. temporal artery. The terminal branches involve and perforate the gland in great numbers. Some of them, however, have different destinations. Two are termed the *external palpebral*—the *inferior*, passing under the gland, reaches the orbicular muscle, where it forms an arch on the lower margin of the tarsus, and anastomoses with branches of the inferior palpebral, and superficial temporal arteries; the *superior* mounts over the gland and passes to the upper lid. Other twigs of the lachrymal artery are lost in the tunica conjunctiva and eyelids.

Cloquet remarks that the lachrymal artery is sometimes a branch of the middle meningeal. Then it enters the orbit by the foramen lacerum.

b. The *Central Artery of the Retina*, (Arteria Centralis Retinæ.) This delicate little branch arises a little beyond the preceding—sometimes is a branch of one of the ciliary arteries. At a variable distance from the globe of the eye, it pierces the coverings of the optic nerve, and penetrates the substance of the nerve itself, passing longitudinally through it, to the interior of the eye; on reaching which it is resolved into many minute branches, which form, over the inner surface of the expanded retina, a beautiful tissue that may be traced to the ciliary body. One branch may be seen to plunge into the vitreous humour, and after giving branches to it, to seek the posterior part of the capsule of the crystalline lens.

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injury. If this cannot be effected, the common carotid should be tied, and compression used to arrest the recurrent hemorrhage.

Ophthalmic Artery. It would be a very peculiar injury, which should inflict a wound upon the ophthalmic artery behind the globe of the eye, without causing the complete destruction of that organ. And even if such an injury should occur, the case would probably neither require, nor admit of surgical interference. Even when we extirpate the eye, we are compelled to trust to the spontaneous cessation of hemorrhage from this artery, aided by the introduction of pledgets of soft lint, and the use of gentle compression.

The cellular tissue, in which the eye is imbedded in the orbit, involves such a multitude of the tortuous branches of this artery, and the anastomoses among these and between them and adjacent branches of the external carotid are so

2. Branches which arise from the Ophthalmic Artery in its passage over the Optic Nerve.

c. The *Superciliary Artery*, (Arteria Supra-Orbitalis,) is a small branch sometimes springing from the lachrymal. It winds its way forward, between the upper walls of the orbit and the levator of the upper lid, beneath the periosteum. Giving off some minute branches to adjacent muscles and to the periosteum, it reaches the margin of the orbit, over which it winds, through the superciliary notch. Then it divides into two branches. The *internal* of these ascends upon the forehead, behind the currugator and orbicular muscles, and is abruptly resolved into muscular and anastomosing twigs, which meet those of the frontal and temporal arteries. Its fellow, the *external*, pursues a similar course, and gives off long twigs which communicate externally with branches of the lachrymal artery.

d.d.d. The *Short Ciliary Arteries*, (Arteriæ Ciliares Breves.) These are very numerous minute branches which pierce the posterior walls of the globe of the eye to supply its interior tissues. They vary in number, from fifteen to forty. Most of them spring from the ophthalmic artery, but some arise in an inconstant order from the lachrymal, ethmoidal, and muscular branches. In their courses, they are remarkably serpentine, that they may neither suffer injury from, nor impede the motions of the globe. They are involved in a mass of adipose tissue which surrounds the optic nerve. Small twigs from them enter the groove which encircles the nerve where it pierces the eye, and, with ramuscles of the ophthalmic, form a circle around it.

But most of the ciliary twigs, on reaching the posterior part of the globe, pierce the selerotica near the optic nerve. Some are appropriated to this membrane; but most of them insinuate themselves between it and the choroid tunic, and are resolved, at acute angles, into very numerous ramuscles, which run forward nearly parallel with each other. They advance, upon the external surface of the choroid tunic, and, anastomosing reciprocally, form an exceedingly close and complex web, of which the meshes are quadrangular. Some communicate with the anterior ciliary arteries—others, piercing the ciliary body, form the great arterial areola of the iris. Most, however, are seen to pass in great numbers to the ciliary processes, in the substances of which they pass tortuously, re-uniting to form larger twigs, which coalesce behind the iris and form an arch.

e. e. The *Long Ciliary Arteries*, (Art. Ciliares Longæ,) are larger than the last described, and are two in number, an *internal* and an *external*. They pierce the selerotica farther from the optic nerve than the short ciliares, and pass directly forward, between this coat and the choroid, giving off small twigs in their

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frequent and free, that, as we should expect, this region is the frequent seat of the disease termed aneurism-by-anastomosis, or *vascular concrescence*. In two instances, I have seen the eye nearly crowded from its orbit, by the morbidly multiplied convolutions of these vessels. They could be distinctly felt, around the margin of the orbit, protruding the lids, and obscurely pulsating. In one case, the ligature of the common carotid was resorted to with only temporary benefit. The probability is that such an operation would prove too often unavailing, in consequence of the free anastomoses which the internal carotids have with each other. Perhaps, as a dernier resort, the ligature of the two carotids successively might be employed.

The *Supra-Orbitar*, *Infra-Orbitar*, and *Nasal* branches are exposed to occasional injury, where they issue from the orbit, but their hemorrhage can always be controlled by compression.

Cerebral Branches. The cerebral arteries of considerable size are rarely, if ever, wounded without an immediately fatal result; and if they were, they would be inaccessible to the hand of the surgeon. There is one circumstance in regard to them, however, which deserves to be noticed in its surgical relations, and that is the free communication which those of opposite sides have with each other in the circle of Willis. From this it is obvious why the ligature of one of the carotids, will sometimes only temporarily influence a vascular tumour on the head, and why a hemorrhage from a wounded carotid will speedily prove fatal, unless it be tied both above and below the place of injury. Hence, also, it is apparent that, if even both carotids were successively obliterated, the brain would still receive, through the vertebrals, sufficient blood to sustain its functions.

passage, to reach the corpus ciliare. Here, each divides at a very obtuse angle into two branches; these, anastomosing with twigs of the anterior ciliares, form a vascular circle upon the large circumference of the iris. From the inner border of the circle, little branches pass inward like the radii of a circle;—they soon divide and anastomose laterally with each other, so as to form another arterial halo, within and concentric with the first. From this last arise many minute twigs, which still converge toward the pupil, around the border of which they again anastomose and form a third circle. In the fœtus, numerous branches leave the great arterial circle, to anastomose freely between the laminæ of the membrana pupillaris.

f. The *Superior Muscular Artery*, (Ramus Muscularis Superior,) ascends to the inferior part of the rectus superior muscle, and is resolved into branches which supply it, the levator of the upper lid, and the superior oblique muscle. When this artery is wanting, which is often the case, these organs are supplied from the collateral branches already described.

g. The *Inferior Muscular Artery*, (Muscularis Inferior,) is much larger, and constant. It arises among the ciliares and passes forward between the optic nerve and the depressor muscle of the eye, to which it gives twigs, as well as to the abductor, the inferior oblique, the lachrymal sac, &c. Its continued trunk sometimes issues from the orbit, on the outside of the eye, and forms an arch with the infra-orbitar. The artery of the retina is sometimes a branch of it.

From the muscular arteries, and often from collateral branches, spring the four or five *anterior ciliary arteries*, which pierce the ball of the eye near the cornea, first giving twigs to the conjunctiva. They chiefly join the great arterial circle of the iris.

3. *Branches which arise from the Ophthalmic Artery, on the inner side of the Optic Nerve.*

h. The *Posterior Ethmoidal*, (Ethmoidalis Postica,) is small and inconstant. It passes along the inside of the orbit, between the superior oblique and abductor muscles, and enters the posterior, internal obitar canal, along which it passes, giving twigs to the cells, till it enters the cranium and is lost on the dura mater of that region, sending some of its twigs, however, back into the nasal fossæ, through the cribriform plate.

i. The *Anterior Ethmoidal Artery*, (Ethmoidalis Antica,) arises from the ophthalmic far forward in the orbit, and soon enters the anterior internal orbitar foramen, together with the internal nasal nerve. It gives twigs to the frontal sinus and anterior ethmoid cells. It then enters the cranium by the side of the crista galli. Some of its numerous twigs pass to the falx, but most of them enter the nasal passages by the ethmoid holes, to be appropriated to the pituitary membrane.

j. The *Inferior Palpebral*, (Palpebralis Inferior,) when not a branch of the nasal, springs from the ophthalmic artery beyond the pully of the superior oblique muscle. It descends behind the insertion of the orbicularis, giving twigs to that muscle, the lachrymal sac, and the caruncle. It then divides, sending one branch to the inferior portion of the orbicularis, and the other along the convex edge of the inferior tarsus, giving twigs to the cartilage, the glands of Meibomius, the conjunctiva, and the skin.

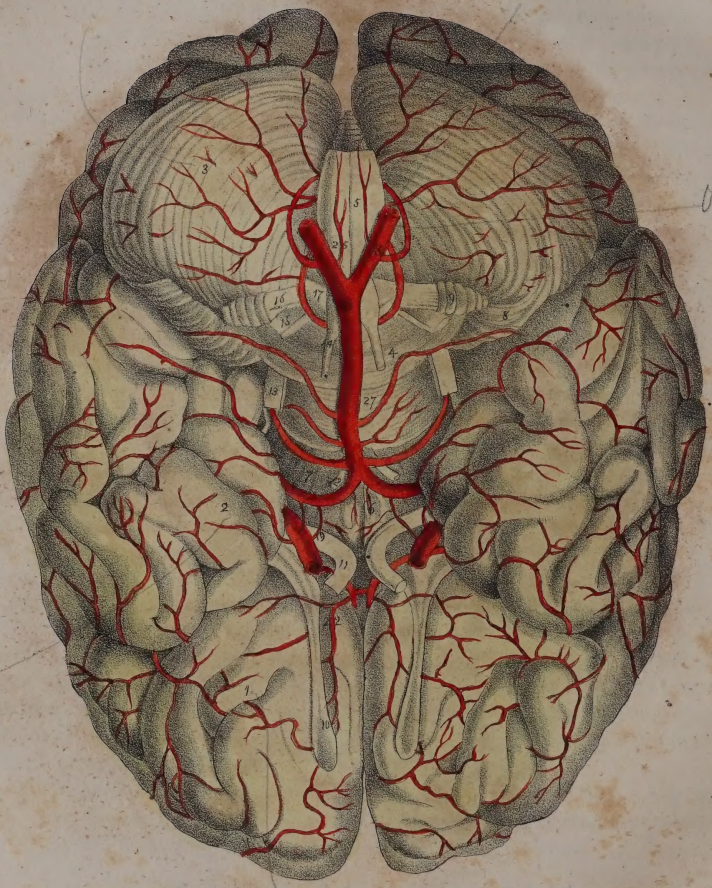
k. The *Superior Palpebral*, (Palpebralis Superior,) arises near the preceding. It pierces the muscle, giving twigs to its upper half—to the sac, the caruncle and conjunctiva, and then passes outward, along the superior tarsal cartilage, and terminates by anastomosing with lachrymal twigs.

4. *Terminal Branches of the Ophthalmic Artery.*

l. The *Nasal Artery*, (Nasalis,) escapes from the orbit above the tendon of the orbicularis and passes to the root of the nose. In its exit, it gives twigs to the sac and muscles. It forms a complex tissue by its sub-divisions and anastomoses with the facial artery. This artery is variable in magnitude—sometimes quite large.

m. The *Frontal Artery*, (Frontalis,) the last of this tedious series, issues at the upper and inner part of the orbit. It winds over the frontal bone, behind the orbicular muscle, and is resolved into three superficial branches, which sub-divide indefinitely, in the orbicular, frontal, and corrugator muscles, and anastomose with twigs of the other side, and with the superficial temporal.

Pl. 5.



Drawn on Stone by S. Smith

G. Willig's Lith.

The Internal Carotid, having given origin to the ophthalmic artery, rises towards the base of the brain and is abruptly resolved into numerous branches which are appropriated to the cerebrum. The first of these is

2. The *Communicating Branch of Willis*, (Art. Communicans.) This artery passes backward and inward, by the side of the infundibulum, and over the mammillary eminences. It is overspread by the arachnoid membrane, and is on the inside of the thickened edge of the middle lobe of the brain, as it passes to inosculate with the posterior cerebral—a branch of the basilar. It varies in size and position. It gives twigs to those parts in its vicinity which we have named—also to the choroid plexus and peduncles of the brain.

3. Next, is the *Artery of the Choroid Plexus*, (Choroidea,) a smaller twig, proceeding obliquely outward and backward, toward the crus cerebri, by the side of which it pierces the floor of the lateral ventricle, and sub-divides in the choroid plexus. It gives twigs to the thalamus nervi optici.

4. The *Anterior Cerebral Artery*, (Art. Cerebri Anterior,) is a considerable branch. It passes forward, inclining a little inward, between the optic nerve and the contiguous portion of the anterior lobe of the brain. It reaches the fissure which separates the hemispheres anteriorly, giving twigs to the optic and olfactory nerves. Then the artery closely approaches its fellow of the other side, and unites with it by a branch, very short, but of considerable diameter. This is termed the *anterior communicating*. It sends small twigs to the fornix, the anterior commissure, and septum of the ventricles. The anterior cerebral arteries then continue forward, parallel with each other, between the hemispheres, and mount upward over the extremity of the corpus callosum. They then pass longitudinally backward, over the superior surface of this body, curving so as to correspond to its arched form, and terminating by sub-division at its posterior extremity. This portion of the artery is termed *arteria callosa*. As it stretches along the convex surface of the corpus callosum, it gives to this body, and to the hemispheres, branches which ramify in the sulci, and inosculate with the posterior and middle cerebral arteries.

5. The *Middle Cerebral Artery*, (Arteria Cerebri Media.) This being the most considerable branch of the internal carotid, and more directly continuous with it, is regarded as the continued trunk. It passes directly, to plunge into the fissure of Silvius, but in its passage it gives twigs to the lower regions of the brain, the pia mater, and the choroid plexus. On entering the fissure, it is resolved into two branches, the one to the anterior, and the other to the middle lobe of the brain. These branches follow the fissure outward and backward, being deeply buried in it. Some of their twigs reach the posterior part of the brain. In every part of their course, they give off branches which enter the cerebral sulci and ramify in the pia mater to extreme minuteness, so as to form a close arterial tissue in that membrane. From this, the minute capillaries of the artery enter the brain.

The Basilar Artery (Arteria Basilaris.) Although we have not described the trunks from which this artery is derived, yet for the sake of unity in regard to regions, and to complete now the description of the *arteries of the brain*, we shall consider the basilar as arising from the two vertebral arteries, which enter the occipital foramen beneath the spinal marrow. These arteries coalesce to form the basilar, a little behind the groove which separates the medulla oblongata from the pons varolii. From this point, the basilar passes

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INDEX TO PLATE V.—Brain and its Arteries.—No. 1, anterior lobe of the Cerebrum; 2, middle lobe; 3, lateral lobe of Cerebellum; 4, Pons Varolii; 5, Medulla Oblongata; 6, Corpora Albicantia, the infundibulum being seen below; 7, Crus Cerebri; 8, 9, vermiform Appendices; 10, Olfactory, or 1st pair of nerves; 11, Optic, or 2d pair, uniting beneath the infundibulum; 12, 3d, or Motor Oculi; 13, 5th, or Trigeminus; 14, 6th, or Abductor; 15, 7th nerve; 16, 8th nerve; 17, 9th nerve; 18, *Inter. Carotid A.;* 19, posterior communicating branch; 20, anterior Cerebral; 21, ant. communicating; 22, branch to the ant. lobe and 1st nerve; 23, Vertebral; 24, posterior, inferior Cerebellar; 25, anterior Spinal; 26, Basilar; 27, branch to the pons and cerebellum. The anterior (superior) Cerebellar, is seen resting on the crus of the brain, and winding round the pons Varolii. The Basilar then divides close to the corpora albicantia, into the posterior cerebral arteries.

upward and forward, along the median groove of the pons, and terminates at a point which is between the peduncles of the brain. It rests upon the basilar groove of the occipital bone. The basilar, in its course, gives origin to numerous small and variable branches appropriated to the medulla oblongata, the nerves which arise from it, the pons and cerebellum. The artery, with its branches, is overspread by the arachnoid membrane. The larger branches of the basilar are

The *Inferior Artery of the Cerebellum*, (Arteria Cerebelli Inferior.) This artery is perhaps more frequently a branch of the vertebral than of the basilar; but as it is very often a branch of the latter, we prefer to describe it here in association with the arteries of the brain. It runs tortuously downward and backward, between the vagus and spinal accessory nerves, giving branches to them, and having arrived at the median fissure of the cerebellum, where it is very tortuous, it is resolved into branches which ramify in the pia mater, and spread their ramuli over the lobes of the lesser brain. Its branches anastomose with those of

The *Superior Artery of the Cerebellum*, (Arteria Cerebelli Superior.) This vessel springs from the basilar near its termination. It insinuates itself into the sulcus between the pons and crus cerebri, passing round the former to ascend upon the upper surface of the cerebellum. In this course, it sends many branches to the pons, the tubercula quadrigemina, the plexus choroides, and the valve of the brain. Some of the numerous terminal branches of this artery ascend upon the posterior lobe of the cerebrum. They every where sub-divide to indefinite minuteness in the pia mater.

The *Posterior Cerebral Artery* is one of the symmetrical branches into which the basilar divides at its termination. It is much larger than the last described. It passes forward, outward, and then backward, having the motor nerve between it and the superior cerebellar. It then crosses the crus of the brain, and gains the lower part of the posterior lobe of the cerebrum. As it passes, it gives branches to the crus of the brain and to the mammillary eminences. One branch enters the third ventricle, and supplies the thalamus nervi optici, the corpora striata, and fornix. Where it touches the motor nerve of the eye, it receives the *communicating artery* of Willis which we have described as a branch of the internal carotid. Beyond this, branches pass to the monticulum cerebri, choroid plexus, thalamus, cornu Ammonis, pineal gland and tubercula. The branches which overspread the lobes of the brain are very numerous: lodged in the sulci they divide and sub-divide—then are woven into the pia mater, and being resolved into vessels of capillary minuteness, pierce the brain.

It will be observed that the arteries which we have described—that is, the communicating artery of Willis, the anterior cerebral, the anterior communicating, and the posterior cerebral, form a sort of polygon, or irregular circle, termed the circle of Willis. Within this are situated the mammillary eminences, the infundibulum, and pituitary body.

SECTION II.

ARTERIES OF THE THORACICO-CERVICAL REGION, AND OF THE SUPERIOR EXTREMITY.

THE SUBCLAVIAN ARTERIES.

We have already described the origin of each of these great trunks (Arteriæ Subclaviæ,) which spring, the one from the innominata, and the other from the aorta, to supply the thoracico-cervical region, and the superior extremities. From their places of origin behind the sternum, these arteries emerge from the mid region of the thorax, and mount upward and outward, to arch over the conical summits of the pluræ, between the thorax and the neck, and reach the shoulders and arms. As their origins are different, these vessels cannot be symmetrical throughout, either in regard to length, direction, or relations. To a certain extent, therefore, they must be separately described.

The Right Subclavian, (S. Dextra,) from its point of origin behind the sterno-clavicular articulation, ascends obliquely outward, arching over the summit of the right pleura, above and behind the inner portion of the clavicle. It then becomes horizontal, merges itself between the anterior and middle scaleni muscles, and crosses obliquely the first rib, into which these muscles are inserted. It issues from the interstice on the outside of these muscles, and still curving, begins to descend on the oblique face of the rib. It then again passes behind the clavicle, near its middle, dropping over the outer margin of the rib, and continuing obliquely outward and downward, issues from beneath the clavicle, under the great pectoral muscle. Having changed its relations, it now loses its name, and becomes the axillary.

To render the relations of this important vessel the more intelligible, we shall adopt the method of dividing its course above described into three sections—the first, that in which it ascends, from its origin, to the inner margin of the scalenus muscle—the second, that in which the artery passes between the scaleni muscles—the third, that in which it dips beneath the clavicle to become the axillary.

In the first section of its course, the direction of the artery is more outward than upward. It is covered anteriorly; first, by a firm fascia which is prolonged from that which envelopes the innominata; next, by the origins of the sterno-hyoid and thyroid muscles, and by cellular tissue which overspreads them, involving some small blood-vessels; exteriorly to these, by the sterno-mastoid muscle, the cervical facia, and the common integuments. Besides these general coverings, the artery is crossed, almost at right angles, by the nervus vagus, the internal jugular vein, and the vertebral veins; also, by the branches of the second cervical ganglion of the sympathetic nerve. As the nervus vagus crosses the artery, it throws off its inferior laryngeal branch, obliquely inward, backward and then upward, beneath the root of the vessel—thus, as it were, casting a loop beneath it. A small quantity of cellular tissue and a few glands, separate the artery behind from the longus colli muscle, and the vertebræ. Obliquely beneath, behind, and on the outside of this section, the pleura is situated. Around that portion of the subclavian which is just within the border of the scalenus, its own branches cluster, in a manner hereafter to be described.

In the second section of its course, (its transit through the scaleni muscles,) the artery lies before and above the summit of the pleura, and, further outward, upon the middle scalenus. The anterior scalenus is before it, and, more superficially, is the clavicular origin of the sterno-mastoid and the platysma myoides. The subclavian vein is anterior and below, being separated from it by the scalenus anticus, as is also the phrenic nerve, which lies obliquely on the face of the muscle.

SUBCLAVIAN ARTERY.

Subclavian Artery. The surgery of the subclavian artery is exceedingly interesting and important;—hence, in the above description of its anatomical relations, I have been copious and particular. It is but recently, however, that surgery has asserted its province over organs of such fearful importance, and thus dared to approach the very precincts of the heart.

The subclavian artery is not unfrequently the seat of aneurismal enlargements. When these occur in the first section of its course, as the external development of the tumour will be resisted by the strong muscles which cover its transit from the chest, the disease is extremely difficult of diagnosis. The tumour encroaches upon other organs not previously concerned in disease, embarrasses their functions, and disturbs their relations. Even the very character of the tumour is then liable to be mistaken, since even a diseased gland lodged in this situation, would necessarily receive a powerful impulse from the great arteries with which it would be in contact. Diagnosis in such a case is only to be established by carefully collating all the local circumstances, and then appealing to the general traits of aneurism, such as the pulse, the general condition of the arteries, the diathesis, &c. &c. Aneurism of the first section of the subclavian, besides the usual phenomena of the disease, will necessarily impede respiration by pressure on the trachea,—deglutition, also, by similar interference with the œsophagus. It will impede the return of venous blood, by pressure upon the subclavian vein, thus rendering the veins of the neck and arm turgid, and those regions œdematous. The pneumo-gastric nerve might suffer mechanical injury, and the organs which it supplies become embarrassed in their functions.

In the third section of its course, in which the subclavian emerges from beneath the scalenus, and drops over the outer margin of the rib, to sink behind the clavicle, the artery rests, behind, on the middle scalenus, and below, on the inclined surface of the first rib. It is covered anteriorly by cellular membrane, the cervical facia, and the platysma myoides. Above, and on the outside of it, is the brachial plexus of nerves, (one branch of which inclines to the front near the lower part of this section,) and the inferior belly of the omo-hyoid muscle. The subclavian vein, partly concealed by the clavicle, is below and in front, converging toward the artery. In this region, also, the external jugular vein dips behind the border of the sterno-mastoid to join the subclavian, passing across the course of the artery. Some variable cervical and clavicular veins, are also here situated. Crossing horizontally beneath these veins, are commonly two branches of the subclavian artery, which throw themselves in front of their parent trunk. The first of these, the supra-scapular, often wanting in this place, meanders horizontally behind the border of the clavicle, often throwing its serpentine arches above the bone. The second, the transversallis colli, passes outward, above and in front of the artery. The space in which these organs are thus located, and through which the third portion of the S. A. passes, is a quadrangular fossa, bounded within by the clavicular border of the sterno-mastoid; on the outside, by that of the trapezius; above, by the omo-hyoid; and below, by the clavicle.

As the clavicle ascends and descends to a considerable extent in the movements of the shoulder, it is obvious that the position of this bone, relative to the artery and adjacent organs, must depend in a degree upon the attitude of the shoulder. When the muscles of the shoulder are quiescent, and the arm drops by the side, the arch of the subclavian rises completely above the level of the clavicle. If the shoulder be drawn upward and forward, then the artery seems to retreat behind it, and but a small portion of it is visible, remote from the integuments. When the shoulder is forcibly pulled downward, the artery seems to arch still higher than in the first case, and becomes very conspicuous above the clavicle. In different subjects, also, the clavicle arches upward in variable degrees; which renders the vessel more or less accessible in different individuals.

The Left Subclavian, (A. Subclavia Sinistra,) is generally a little smaller, and necessarily longer, than the right. Arising from the descending part of the arch of the aorta, deep in the thorax, opposite to,

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Aneurism rarely, if ever, occurs primarily in the second section of the course of the S. A. because of its being embraced and sustained by strong muscles. The third section, in which it becomes more superficial and loose in its connections, is a frequent seat of aneurism. Here, as I have learned from observation, there is but little difficulty in establishing the character of the disease. The tumour protudes without much impediment, from the fossa between the trapezius and the sterno-mastoid muscles. Extreme pain will be produced in the shoulder and arm, perhaps paralysis and œdema in the latter, by pressure upon the brachial plexus of nerves, and upon the subclavian vein.

Aneurism of this artery, on which ever side of the scaleni muscles it commences, is not readily extended beyond this barrier, to the other portion of the artery. This is because of its being there so effectually sustained by the muscles. I have recently witnessed the dissection of an aneurism of the trans-scalene portion of the artery, in which the tumour was abruptly arrested at this gate-way, the undilated, though diseased artery seeming to be implanted upon the very body of the tumour.

It was aneurism of the subclavian artery, originating, or extending within the scaleni muscles, that sanctioned the bold attempts which have been made to obliterate with the ligature the arteria innominata. I have already expressed my opinion, that, although circumstances may warrant the further trial of this perilous expedient, the operation will probably never be successfully accomplished. The success of the operation, however, is not defeated by the arrestation of the current of blood to the parts supplied by this great vessel. The cases of Mott and Graefe, the only two of which I have seen any satisfactory account, render argument altogether superfluous, to show that blood can reach those parts by collateral channels. The difficulty results, not only from the magnitude of the vessel, and its proximity to the aorta and heart, but from the almost uniform existence of disease of the innominata, when disease has invaded the root of the subclavian.

and a little on the left of the second dorsal vertebra, it ascends almost perpendicularly, till it approaches the inner border of the first rib. It then curves outward, to insinuate itself between the scaleni muscles, and to pursue a route and assume relations precisely similar to those of its fellow. In the first section of its course, its relations are peculiar. It ascends on the left side of the œsophagus, being in contact, behind, with the longus colli muscle, and the sympathetic nerve. Obliquely on the left, and in front of the artery, are the left lung and pleura. The nervus vagus descends in front of it, and the left carotid passes up in front and a little on the right. The thoracic duct ascends behind and on its inner side, but after reaching the seventh cervical vertebra, arches over the artery, just where it merges itself in the muscles, and terminates in the subclavian vein. The vena innominata—the coincident origins of the sterno-mastoid, thyroid and hyoid muscles, also the sternum, first rib, and clavicle, are all in front of this vessel.

The numerous and important branches of the subclavian artery, spring from that great vessel where it lies securely lodged behind the inner extremity of the clavicle, and on the inner side of the scaleni muscles. They cluster so closely around the trunk—some of them arising from points directly opposite to each other, and others originating, sometimes separately, and sometimes by a common trunk, that it is impossible to fix upon any uniform order in which they occur.

1. The *Vertebral Artery*, (Arteria Vertebralis,) is the first and much the largest of the branches which arise from the subclavian. It springs from the superior and posterior aspect of that artery, where it bends outward. On the right side, it forms a very obtuse angle with its parent trunk; but on the left, it is continued in the same line with it. From its point of origin, it ascends directly, between the longus colli, and scalenus ant. muscles, to reach a foramen in the transverse process of the sixth, but sometimes the seventh, cervical vertebra. This is the first of a series of holes formed in the successive processes, and which thus furnish an interrupted canal, transmitting the artery to the head. Where not embraced by these bones, it is enveloped by the inter-transversales muscles. In the first part of its course it is beneath the inferior thyroid artery. Higher, it crosses the trunks of the cervical nerves. Till it issues from the hole in the second vertebra, its course is very direct; but then it is inflected backward under the complexus, and forms a vertical curve, which arches upward, backward and inward. The artery next sallies outward, to the tran. process of the atlas—perforates its base, directly upward—passes backward and inward, between the atlas and occiput, and in the triangular space formed by the recti and obliqui capitis, it forms another curve, which, also arching upward, is covered by the rectus major and complexus. Its concavity half encircles the posterior ligament of the atlas and occiput, (occipito-atlantoid.)

At length the two arteries enter the cranium, by the foramen magnum, on the sides of the spinal marrow, piercing, on each side, the margin of the ligament just named, and the dura mater. They ascend in a serpentine manner, converging beneath the spinal marrow, and meet, to coalesce at an acute angle, beneath the basilar groove and form the basilar artery.

The vertebral gives origin to no branches, till it enters its cervical canal. Then it gives many nameless twigs to the adjacent muscles, and to the spinal column and the medulla. In its first curve, between the two upper vertebræ, it yields a branch which gives one twig to adjacent muscles, and another which enters beneath the arch of the atlas to the dura mater. In its next curve, it also sends twigs to adjacent muscles, and gives origin to one which, anastomosing with its fellow of the other side, forms an arch beneath the complexi and recti muscles.

Where the vertebral artery approaches the corpora pyramidalia, it generally gives origin to the *posterior spinal artery*. This slender vessel descends, inclining inward behind the medulla, as low as to the first, second, or third lumbar vertebra, giving twigs to the membranes. Near its termination, the vertebral gives origin to the *anterior spinal artery*. This meanders upon the anterior face of the spinal marrow, and coalesces with that of the opposite side, at the margin of the occipital hole. The common trunk traverses the whole length of the spinal marrow and cauda equina, to the sacro-coccygeal junction. There its twigs anastomose with those of the lateral sacral arteries.

The destination of the basilar, in the cranium, I have described in association with the cerebral arteries.

2. The *Inferior Thyroid*, (Thyrodea Inferior,) arises a little exteriorly to the last described, and in front of it. It ascends vertically on the anterior face of the scalenus ant. till it reaches the fifth vertebra, and then it is abruptly inflected beneath the common carotid, and passes transversely to the side of the thyroid gland, where it is resolved into its numerous branches.

The inferior thyroid, where it bends inward, sends upward the *ascending cervical*, which rests upon the scalenus and the longus colli muscles; these it supplies, as well as other adjacent muscles, and the lymphatic ganglia.

The posterior and superior scapular arteries not unfrequently spring from the trunk of the inferior thyroid. Small anomalous branches, which in that situation pass outward to the contiguous muscles, are always found.

When the inferior thyroid has reached the inferior, lateral portion of the thyr. gland, it divides into two branches, which insinuate themselves behind the gland, and are then resolved into numerous twigs which pierce that body, to anastomose with those of the corresponding artery, and of the superior thyroids.

3. The *Internal Mammary*, (Mammaria Interna,) arises opposite to the last, and more deeply. It, at first, inclines a little inward, as it descends, on the scalenus m. and on the outside of the phrenic nerve. It then plunges behind the clavicle, and the cartilage of the first rib, insinuating itself between the pleura and this last. It descends directly, crossing transversely the costal cartilages, and having the intercostal muscles in front of it, where the cartilages are not present. It inclines to the margin of the sternum, passes between the triangularis sterni and the thoracic walls, and reaches the ensiform cartilage. There it is resolved into two branches, of which the *external* inclines outward to the inferior costal cartilages, and gives twigs to the origin of the diaphragm, and to the transverse and oblique muscles, anastomosing with the intercostal, lumbar, and circumflex iliac. The *internal* descends behind the rectus muscle, giving branches to it, and anastomosing with the epigastric.

The branches given off by the internal mammary, in its descent, are numerous. First, it gives nameless twigs to the thymus gland, neighbouring muscles, and lymphatic glands. Next, there generally springs from it the *anterior mediastinal artery*, which enters the anterior mediastinum. It gives twigs to the pericardium, and then is resolved into two branches, one of which goes upward, behind the sterno-thyroid muscle, to the thyroid gland—the other descends in the mediastinum, and gives twigs to adjacent parts.

The *Superior Phrenic*, very small, leaves its parent at the margin of the sternum, joins the phrenic nerve, and with it, passes downward, backward and inward, between the pericardium and lung. It gives twigs to the pericardium—the ph. nerve, the mediastinum, the lung, and the adjacent veins. It terminates, with the ph. nerve, in the diaphragm.

External and Internal Branches. The *External* correspond in number to the intercostal spaces, to which they are appropriated; running along the inferior margin of each cartilage to be lost in the intercostal muscles, and inosculate with the intercostal arteries. Some branches there are, which perforate the muscles, and reach the pectoral muscles and mamma,—hence the name of the parent trunk. The lower twigs are the larger.

Internal Branches. They approach the sternum, giving twigs to its posterior face—then they pierce the intercostal muscles, close to this bone—are reflected outward, on the outer surface of the thorax, to the great pectoral, external oblique, and rectus adominis muscles. The last branch bends inward, over the ensiform cartilage, forming an arch with its fellow.

4. The *Superior Intercostal*, (Intercostalis Superior,) arises from the posterior and inferior aspect of the subclavian, exteriorly to the last. It descends on the neck of the first rib, on the outside of the inferior cervical ganglion. After crossing the first rib, it gives off one *external* branch to the intercostal muscles—another, *posterior*, by the intervertebral foramen, to the spinal marrow and the dorsal muscles. Sometimes the artery terminates here; but oftener it crosses the second rib, and sometimes the third, giving off other similar twigs. In its whole route the artery is beneath the pleura.

5. The *Transverse Cervical*, (Transversalis Cervicis,) is sometimes a branch of the thyroid, but when not, it arises from the same aspect of the parent trunk, and nearly opposite to the s. intercostal. It stretches transversely outward and a little upward, emerging from beneath the margin of the scalenus ant. (sometimes crossing over it,) then crossing the nerves of the brachial plexus, in the angle between the sterno-mastoid and trapezius muscles. It then retreats backward, under the trapezius and levator scapulæ; but finally descends vertically, under the rhomboid muscle, and terminates in the parts adjacent to the lower angle of the scapula.

At a brief distance from its root, the transverse cervical gives origin to the *superficial cervical artery*, which ascends tortuously, inclining outward and backward, to the splenius and trapezius muscles. It passes under the lavator scapulæ. Opposite to the rhomboid muscle, the transverse cervical, is resolved into two branches, one of which runs along the posterior border of the scapula and is appropriated to the muscles there inserted. The other passes beneath the scapula, to the subscapular muscles.

Occasionally the transverse cervical is a branch of the axillary, and then, instead of crossing the brachial nerves, it passes in the interstice between two of them.

6. The *Supra-Scapula*, (Supra-Scapularis,) is said most frequently to be a branch of the in. thyroid; but I have more generally found it to arise from the S. Sometimes it arises by a common trunk with the t. cervical, or mammary. It meanders outward, behind the upper border of the clavicle; at different points rising above and sinking below it. In this course, the artery is covered by the sterno-cleido-mastoid musc. the platysma and trapezius. With the supra-scapula nerve, it reaches the superior border of the scapula—passes above the coracoid ligament—insinuates itself between the supra-spinatus muscle and the spine of the scapula—there bends outward under the acromian process, and doubling round its root, enters the fossa below the spine.

Near its origin, the supra-scapular gives irregular branches to contiguous muscles—the clavicle—glands and cellular tissue of the neck. Before crossing the ligament, it sends a considerable branch to the supra-spinatus muscle. This branch imparts twigs to the trapezius and to the joint of the clavicle and acromian. Below the spine it anastomoses with the sub-scapular. It there also divides into two branches, one which passes along the anterior edge of the scapula to the teres major and latissimus dorsi muscles. The other winds backward under the spine of the scapula, and gives twigs to the infra-spinatus muscle.

7. The *Posterior Cervical Artery*, (Cervicalis Posterior,) springs from the posterior part of the S. behind the scalenus muscle. Sometimes is arises from the thyroid, vertebral, or intercostal. It ascends obliquely outward, giving twigs to the scaleni, longus colli or other adjacent muscles. Then it passes upward, and bends inward, between the complexus and the semispinalis colli, giving numerous twigs to the muscles and integuments of the back part of the neck.

The Axillary Artery, (Arteria Axillaris.) This important vessel is directly continuous with the subclavian, but assumes a new name as it assumes new relations. Cloquet regards it as commencing at the external interstice of the scaleni muscles, but such is not the common acceptation. I shall consider the

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The *Ligature of the* Subclavian, *in the first section of its course*, before it reaches the scaleni muscles, is, in many respects, an operation more difficult and perilous than that of the innominata. Although a smaller artery, its relations are more complicated, and it is less safely accessible. The jugular vein—the par-vagum—the recurrent nerve—the sympathetic filaments, are all obnoxious to the knife. The numerous branches which cluster round this section of the artery, also interpose themselves; and when the subclavian is safely reached, as the ligature must be fixed in the vicinity of one of them, secondary bleeding may defeat a favourable result. The memorable case of Mr. Colles, in which this section of the artery was tied in Stevens' Hospital, in 1813, proved speedily fatal, before the ligature separated, apparently from the degree of injury inflicted upon the adjacent organs. On the left side, the artery being more deeply seated, and having still more complicated relations, the operation is absolutely impracticable.

axillary as commencing where the artery has fairly passed over the rib and is emerging from beneath the subclavius muscle. Its general direction is outward and downward, through the region denominated the axilla, or arm-pit, as far as to the inferior border of the latissimus dorsi muscle, where it becomes the brachial. In this course it describes a gentle curve, the concavity of which looks inward and downward.

At its origin, the artery is situated directly beneath the subclavius muscle. A little lower it is invested anteriorly by a quantity of loose cellular tissue, involving glands, small blood-vessels and nerves. This tissue is often a strong fascia extending from the subclavian muscle to the coracoid process. More superficially, in the same region, is the great pectoral muscle, the fibres of which cross the artery obliquely outward. Still lower, about an inch or more below the subclavius, the artery plunges beneath the pectoralis minor muscle, decussating it obliquely. On issuing from beneath this muscle it has the tendon of the great pectoral, and the coraco-brachial and biceps muscles, in front of it.

Posteriorly it rests, at its upper part, on the cellular tissue which separates the serratus magnus and the subscapularis muscles. Obliquely on the outside, and behind it, it has the teres major and latissimus dorsi. On the inner and posterior side, it traverses the first intercostal muscle, then the second rib, and the upper digitation of the serratas magnus. On the outer side, it has, as it descends, the capsule of the shoulder joint—then the sub-scapularis muscle, and finally, the tendons of the teres major and latissimus dorsi, which separate it from the upper and posterior part of the humerus.

The relations of the artery to the vein and brachial plexus of nerves are very important. At its commencement the A. A. has the nerves on the outside and behind it, but as the vessel descends, the plexus throws some of its branches obliquely over it, in front, so that when the artery has passed beneath the pectoralis minor, it becomes completely involved in them. The vein is at first obliquely within and before; but below, this also inclines to the front, and is in contact with the nerves before the artery. The vein, both here and above, gives origin to small branches which pass across the artery and interlace with the brachial nerves; these confine the vein in front of the artery. Some of its smaller branches are also found in this region in front of the artery, involved in the plexus of nerves and veins.

To facilitate description, we divide the numerous branches of the axillary into two orders—1st, Those which arise from the trunk, where it rests on the thorax; 2d, Those which spring from it in the axillary space, and near the humerus.

1. *Branches arising from the trunk where it rests on the Thorax.*

1. The *Acromial Artery*, (Thoracico-acromialis,) a branch of considerable size, arises from the A. just before it merges itself behind the border of the lesser pectoral muscle. Its origin is nearly opposite to the

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If the surgeon, when the artery cannot be safely secured beyond the scaleni, would attempt the ligature of the right subclavian on the tracheal side of the muscles, the following method will be found the most practicable.

The patient being placed in the supine posture, and the head being gently thrown backward, the operator incises the integuments to the extent of three inches, along the upper border of the clavicle. This exposes the clavicular origin of the sterno-mastoid muscle, which is then to be transversely divided, with the aid of the director. Subjacent cellular tissue is then to be cautiously removed, together with small vessels which are involved in it. The co-incident origins of the sterno-hyoid and thyroid muscles are now exposed, and are to be divided in the same manner. A narrow spatula may, for security, be thrust beneath them. Such an instrument, with a longitudinal groove in its centre, would be convenient for this purpose. The internal jugular vein is then seen on the right and in front, and is to be gently pressed outward with a flat retractor. The subclavian is found between this vessel and the root of the carotid. The par vagum is to be gently drawn from before the artery, towards the trachea. Great care is now to be observed in approaching the trunk, not to inflict injury upon its numerous branches. An opening is to be made in its loose cellular investment by the cautious use of the handle of the knife. The direction of this opening may be vertical, for the purpose of avoiding

Pl. 6.

Drawn on Stone by S. Smith.

G. Willgoss Lith.

interstice between the great pectoral and deltoid. Its course is obliquely forward, outward, and downward, beneath the pectoralis minor, till it reaches the fissure between the muscles already named. There it is resolved into its two principal branches. As it is passing beneath the lesser pectoral, however, it gives origin to small thoracic twigs, which pass transversely before and behind the vein, to the serratus muscle. The first of its terminal branches, the *superior*, ascends tortuously between the pectoral and deltoid, to reach the clavicle;—there it gives twigs to the integuments of the shoulder, and to the deltoid. It now passes beneath the deltoid, and being resolved into two branches, it sends one of these, (the proper acromial,) along the margin of the clavicle, to the acromial joint;—the other ramifies over the capsule of the shoulder

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to lacerate the filaments of the sympathetic nerve, and to facilitate the passage of the ligature. The thread should be applied as near to the vertebral as possible. The instruments heretofore described may be used for effecting the passage of the ligature.

But it is after the subclavian has emerged from between the scaleni, where it becomes more superficial—less complicated in its relations, and where it usually gives off no branches, that it may be approached with ease, and secured with comparative safety. The happy results of many of the operations which have been performed upon this section of the artery, have demonstrated, beyond all cavil, the propriety of occasionally attempting its obliteration with the ligature, in the treatment of axillary aneurism. It is not my design to detail the history of this, or other operations upon the great vessels, but I cannot forbear to state, that the first who achieved success in this bold attempt, was our distinguished countryman, the late Prof. Post, of New York. Since his operation, the subclavian has been successfully secured in numerous instances. The best method of effecting the application of the ligature is, by most surgeons, believed to be that recommended by Mr. Hodgson.

The shoulder being drawn downward, as far as possible, in order that the clavicle may be removed from before the artery, an incision is to be made just above the clavicle, and parallel with it, from the external border of the mastoid muscle, to the margin of the clavicular insertion of the trapezius. This incision is to be deepened, through the platysma, great care being taken to avoid wounding the subjacent jugular vein, which will be found near the middle of the incision, and may be retracted toward the shoulder. The cellular tissue in the middle of the incision is now to be carefully removed, for the purpose of exposing the external border of the scalenus. In doing this, it must be borne in mind that the superior scapular artery meanders just below this region, sometimes rising into it, and that occasionally another branch of the subclavian, the transverse cervical, passes transversely through it, accompanied with a considerable vein. The eye and the finger, if cautiously employed, ascertain their presence, and they are then to be carefully with-

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INDEX TO PLATE VI.—Is introduced for the purpose of illustrating the relative anatomy of the arteries of the neck. Fig. 1 and 2, mark the sternal and clavicular attachments of the Sterno-mastoid muscle; fig. 3, its mastoid attachment; 4, the Omo-hyoid m.; 5, Sterno-thyroid; 6, Sterno-hyoid; 7, Scalenus Medius; 8, Scalenus Posticus; 9, Levator Scapulæ; 10, Trapezius; 11, Splenius; 12, Scalenus Anticus; 13, Anterior belly of the Digastricus; 14, its tendon; 15, Constrictor Pharyngis inferior; 16, Quadratus Menti; 17, Depressor Ang. Oris; 18, Masseter; 19, Occipito-frontalis; 20, Clavicular portion of the Pectoralis Maj.; 21, Deltoid; 22, Parotid Gland; 23, Submaxillary; 24, Thyroid Gland; 25, Trachea; 26, Carotid Artery; 27, External Carotid; 28, In. Carotid; 29, Sup. Thyroid; 30; Sup. Laryngeal; 31, Lingual; 32, Facial; 33, Transverse Facial; 34, Temporal; 35, Occipital; 36, Subclavian; 37, Superior Scapular; 38, Transverse Cervical; 39, Superficial Cervical; 40, branch of the Ascending Cervical; 41, branch of Internal Mammary; 42, 43, branches of Thoracic Acromial; 44, Vena Facialis Posterior; 45, Vena Facialis Ant.; 46, 47, Exter. Jugular; 48, posterior branch of the Ext. Jug.; 49, a superficial transverse branch; 50, Vena Transversalis Cervicis; 51, Ext. Jugular; 52, Subclavian vein.

NERVES.—*a.* branch of the 3d Cervical; *b.* superficial nerves of the 3d pair distributed to the skin; *c.c.c.* branches of 2d and 3d pairs to muscles; *d.* 9th pair, or Lingual; *e.* and *f.* branches of 9th to hyo-thyroid muscle *g.* branches of 4th pair; *h.* union of the 5th and 6th cervical, to assist in forming the axillary plexus; *i.* union of 7th and 8th cervical and first dorsal which also join the axil. plexus.

joint. Their twigs inosculate with those of the superior scapular. The *inferior* branch passes more obliquely downward, in the same muscular interspace, accompanying the cephalic vein, and is resolved into two branches, the one to the contiguous border of the pectoral, and the other to that of the deltoid muscle.

The acromial artery has often a common origin with the thoracic.

2. The *Superior Thoracic*, (Thoracica Superior,) is often a branch of the last; when not, it arises from the A. sometimes above, but generally below, the acromial, at the very margin of the lesser pectoral muscle. It passes obliquely downward and forward, between the lesser and great pectoral, being resolved into numerous twigs, which are appropriated to these muscles, and inosculate with the mammary and intercostal.

3. The *Thoracico-Axillary*, (Thoracica Axillaris,) arises below the pectoralis minor, and is immediately resolved into numerous branches, some of which are appropriated to the glands and cellular membrane of the axilla, while many others pass across to the intercostal muscles—to the pectoral and sub-scapular. These small twigs, together with corresponding veins and small nerves, sent from the intercostal spaces to the upper part of the arm, form an intricate tissue in this region.

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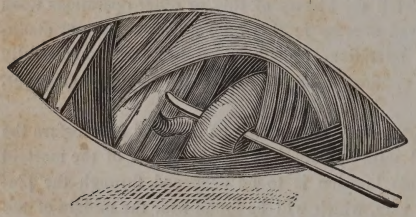
drawn, or divided and secured. The margin of the muscle is now to be traced down to the rib, and in the very angle formed betwen the muscle and the rib, the artery is found. It must be carefully distinguished from the brachial nerves which are above and on the outside of it.



The accompanying cut illustrates the first method of cutting for the subclavian beyond the scalenus. The vessel is seen raised. The brachial nerves are exterior—the ext. jugular still exterior to them. The scalenus is seen within—the clavicle below. Above is seen the border of the fascia.

M. Dupuytren, instead of the horizontal incision, makes one which is nearly vertical—along the outer border of the sterno-mastoid muscle. This divides the platysma and fascia, and exposes the omo-hyoid, where it passes under the sterno-mastoid. The omo-hyoid is then to be divided with the aid of the director. A little tissue being removed, the margin of the scalenus is next exposed, and M. Dupuytren advises to divide the external third, half, or indeed, if necessary, the whole of this muscle, by passing a bistoury behind it, and incising it transversely.

In the division of the scalenus, there must certainly be danger of wounding the phrenic nerve, especially as it sometimes lies on the outer portion of this muscle. The division of the omo-hyoid also complicates the wound, without appearing to facilitate our approach to the artery.

It appears to me that the method most feasible, is that in which the two above external incisions are combined—one along the border of the clavicle—the other coincident with the outer border of the sterno-mastoid. The angular flap thus made is then to be raised—the omo-hyoid and the scalenus exposed as above, and the artery is then found and secured with facility.*

Two or three successful cases demonstrate that the subclavian artery may, though not with the same facility or safety, be secured below the clavicle. This operation might perhaps be preferred for the cure of axillary aneurism, in a case in which the clavicle arched unusually high upon the neck; or it might be resorted to in case of subclavian aneurism, when we would secure the artery on the distal side of the tumour. It may also be necessary to cut for the artery in this region in case of certain wounds. The following is the eligible method.

Make an incision beginning an inch from the sternal extremity of the clavicle, arching a little upward, and terminating near the border of the deltoid muscle, but avoiding the cephalic vein, which lies in the interstice between this muscle and the pectoral. The latter muscle is then to be divided along the whole extent of this cut. The lesser pectoral

* The surgeon should be well aware, that the chief impediment to the application of the ligature to the subclavian, in this region, usually arises from the malposition of the shoulder, it being firmly pressed upward by the axillary tumour, and thus the clavicle carried above and in front of the artery. The artery, therefore, being deeply buried behind this bone, is sometimes almost inaccessible.

4. The *Inferior—Long Thoracic*,—or *External Mammary*, (Thoracica Longa,) arises beneath the pectoral m.—it descends almost directly, resting on the serratus magnus and covered by the inferior border of the great pectoral. It becomes at length superficial, bends inward, and is lost in the integuments which cover the lower portion of the great pectoral, and in the mamma. While some of its branches come round the border of the muscle, others perforate it, to supply the gland. In the above course, this artery gives twigs to the axillary gland—the pectoral, intercostal and serratus muscles.

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is then seen passing obliquely upward and outward, at the inferior part of the wound. Between the clavicle and the border of the muscle, the artery lies, invested by cellular tissue, which often assumes the form of a strong fascia. It has the vein below and in front of it, one of the brachial nerves above and in contact—the remainder of them behind. Some of the thoracic branches of the artery and vein lie in front of the vessel. The loose tissue which confounds these organs is to be lacerated with an obtuse instrument, and the artery is then exposed. When the thread is passed, it must not be hastily tied, till the artery be satisfactorily identified; for one of the brachial nerves, which inclines to the front of it, has been included instead of it.

Vertebral Artery. The surgeon has but little concern with this vessel, except as it may be interested in the operation of securing the subclavian within the scaleni. We have already advised that this vessel be tied as near to the V. as can be effected, in order that the ligature may be as remote as possible from the carotid. It is true that a recurrent stream will subsequently descend the vertebral, and enter the subclavian beyond the ligature; but it will enter with a feeble impulse, compared with that of the current in the carotid, and be infinitely less liable to defeat adhesions.

Internal Mammary Artery. It is easy to conceive that this vessel may be accidentally wounded, so as to require, and admit of, the ligature. It crosses, transversely, the cartilages of the ribs, near their external extremities; commonly inclining inward as it descends. It lies anterior to the sterno-costalis muscle, and, below, is separated by it from the pleura. In the dead subject, it can be cut for and tied without suffering air to enter the cavity of the pleura. If it be cut for, at a hand's breadth below the margin of the sternum, an incision, two inches long, should be made in the intercostal space, parallel with the cartilages. The centre of this incision should be an inch from the sternum. The intercostal aponeurosis is to be divided by passing a director beneath it. The intercostal muscle, for there is here but one, may be divided in the same manner. The artery is then found in the centre of the incision.

Inferior Thyroid Artery. This vessel is deeply buried beneath organs which are far more important than itself. Its trunk can scarcely be wounded, therefore, without a fatal result. Nor could there ever be any propriety in cutting for it, in case of a wound of any of its branches. The tying of *this* vessel, for the cure of bronchocele, as has been practised upon the superior thyroid, is entirely out of the question. Such an operation would be far more difficult than to secure the vessel, in completely extirpating the gland. Then, the artery may be, and has been secured, by dragging outward the vessel, together with the portion of the gland which receives its branches.

Transverse Cervical. I have already remarked that in cutting for the subclavian, on the outside of the scaleni, this vessel may be concerned, as it passes through the upper portion of the space in which the incision is made. In no other respects is it particularly interesting to the surgeon.

Axillary Artery. I have described the method of cutting for, and securing the axillary artery at its origin from the subclavian, in the surgical observations relative to the latter artery. In this I have conformed to the custom of other writers. But the Axillary A. may sometimes be cut for at the lower part of its course—where emerging from the axilla, and issuing from the close embrace of nerves and veins. In this region, the median nerve arises from the brachial plexus by two roots, between which the artery is placed. On the internal side of the artery, are also the internal cutaneous and ulnar nerves; behind it are the circumflex and musculo-spiral nerve. The axillary vein is in front. Sometimes there are two or three veins instead of one.

To secure the vessel at this place; first, let the arm be abducted from the body, and the hand supinated; then, make an incision in the axilla, near the border of the latissimus dorsi, and close to its insertion. The median nerve and axillary veins will thus be brought into view. These may be separated and drawn to opposite sides, when the artery will be exposed. The operator should always be prepared to encounter here anomalous distributions of nerves and veins.

The surgeon should observe that, when the arm is abducted from the body, the artery, vein, and nerves, where they pass to the arm, are carried outward and upward from the axillary space, and that hence, in dissecting away deep glands

2. Branches which spring from the A. in the Axillary Space, and near the humerus.

5. The *Sub-Scapular*, (A. Sub-scapularis,) is much the largest and most important branch of the A. It arises from its parent trunk, near the lower edge of the tendon of the sub-scapular muscle, behind the brachial nerves. It runs backward and downward, along the inferior costa of the scapula, about an inch and a half;—then it is resolved into two branches—the *inferior* and *superior*, of which the latter is the larger.

The *inferior* still descends upon the sub-scapularis muscle, along the inferior costa. Many of its branches enter the sub-scapular muscle, while others reach the angle of the scapula, to pass thence to the walls of the thorax, or to inosculate with the superior.

The *superior*, (regarded as the continued trunk,) bends abruptly around the inferior costa of the scapula, and passes horizontally backward, out from the axilla, through an opening bounded anteriorly by the triceps, below by the teres major, and above by the scapula and muscles attached to the inferior costa. To all these muscles it sends branches. After it is wrapped around the costa of the scapula, it is found in the fossa below the spine, and there is resolved into two twigs—one superficial going to the skin and aponeurosis; the other larger and profound branch, insinuates itself beneath the teres minor and infra-spinatus muscles, and is appropriated to them. One branch ascends beneath the acromian, to the fossa above the spine, and anastomoses with the supra scapular.

6. The *Posterior Circumflex*, (Circumflexa Posterior,) a smaller artery than the last, though of considerable magnitude, springs from the parent trunk, on its posterior aspect, above the head of the humerus. It insinuates itself between the sub-scapularis and teres major muscles, and passes before the long head of the triceps. To these it imparts twigs—passes under the deltoid, and winds round to the fore and outer part of the arm. Ramuli which then originate from it, ascend to the articular capsule, and to the teres minor and infra-spinatus muscles. Other twigs follow the fasciculi of the deltoid muscle, to their termination in the tendon. The branch which may be regarded as the continuation of the artery plunges into the deltoid and inosculates with the

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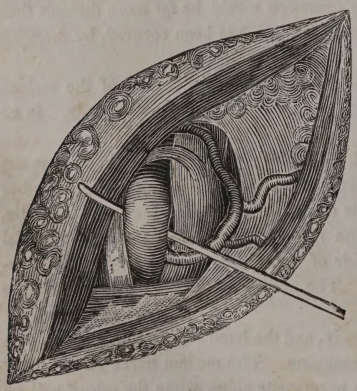
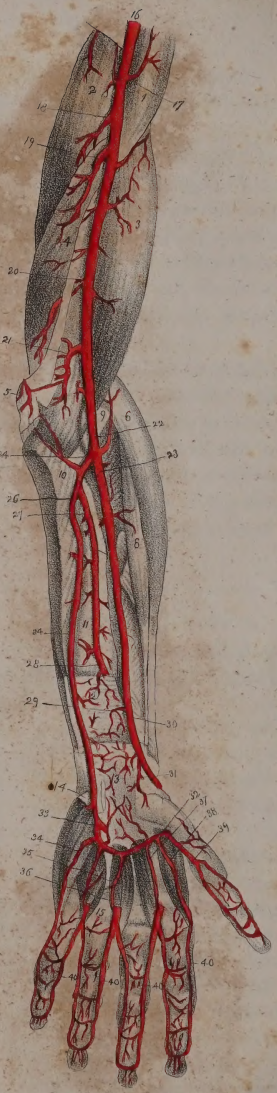
from this region, there is but little danger in directing the knife inward along the ribs; but great danger of wounding the vessels, especially the vein, when the incision is incautiously directed upward and outward. An incision carried too far backward and upward endangers the subscapular A.

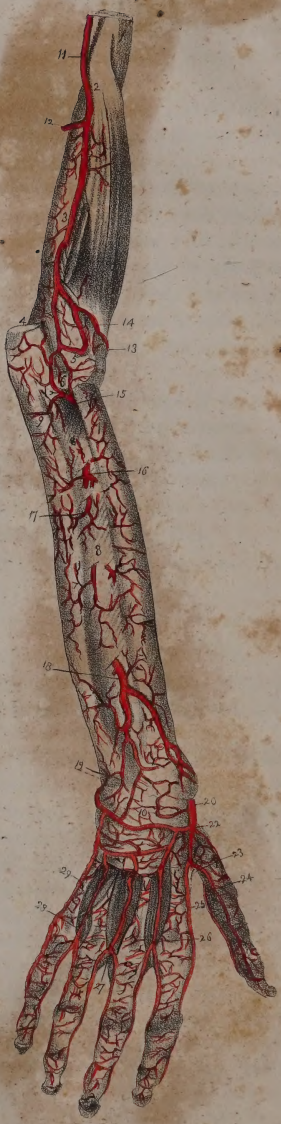


The cut illustrates the mode of raising the axillary artery below the clavicle. The artery is seen raised from between the vein on the inside and the first branch of the bracheal plexus. The branch seen arising from the artery is the thoracic acromial. The border of the fascia is seen externally; that of the pectoralis minor below.

When the A. A. is divided in amputations at the shoulder joint, the gush of blood must be restrained, till the ligature can be applied, by pressure made upon the subclavian with a convenient instrument, above the clavicle, on the first rib, where it crosses that bone. The operator must not expect thus to arrest the hemorrhage completely, both because of the difficulty of compressing steadily so large an artery, while the patient is writhing under the knife and the neighbouring muscles are spasmodically tense, and because of the free anastamoses of this region.

Thoracic Branches of the Axillary. These vessels are concerned in the extirpation of schirrous glands of the axilla—especially those which it is so frequently necessary to remove from beneath the border of the pectoralis major. When they are divided high in the axilla, they often retreat deeply into the loose tissue of that region, and completely escape from the eye and hand of the operator, thus giving rise to a troublesome, perhaps dangerous,





Drawn on Stone by S. Smith

G. Willig's Lith

7. *Anterior Circumflex*, (Circumflexa Anterior.) Often arising from the last, it bends abruptly forward and outward, under the coraco-brachial muscle, and the short head of the biceps, running along the upper margin of the tendon of the latissimus dorsi and teres major. It then passes between the bone and the deltoid, to the groove which lodges the tendon of the biceps—passes under the tendon of the long head of that muscle, and enters the deltoid. It adheres to the periosteum. It gives twigs to all the adjacent muscles, and to the capsule.

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hemorrhage. Hence the precept, in such operations, to secure all bleeding vessels before the parts, by which we may drag down these vessels, are entirely removed; and also, that of occasionally applying a ligature to the last band of tissue which is supposed to contain vessels that may retract.

The Circumflex Arteries are concerned in dislocations of the os humeri, in which injuries they are sometimes lacerated. They are also divided in amputation at the shoulder joint, and in extirpation of the head of the bone; but they are not the subjects of any particular surgical precepts.

INDEX TO PLATE VII.—ARTERIES OF THE SUPERIOR EXTREMITY.—1. The 1st figure on the left represents an anterior view of the Arteries of the Superior Extremity—the skin and cellular tissue alone being removed. No 1, represents the Deltoid m.; 2, the Biceps; 3, the Coraco-brachial; 4, 5, the Triceps; 6, Brachialis int.; 7, intermuscular ligament; 8, tendon of the Biceps; 9, Supinator radii longus; 10, Extensor carpi radialis longior; 11, Pronator radii teres; 12, Flexor carpi radialis; 13, Palmaris long; 14, Flexor carpi ulnaris; 15, 16, 17, superficial and deep Flexors of the fingers; 18, 19, first and second Extensors of the thumb; 20, palmar aponeurosis; 21, muscles of the ball of the thumb; 22, Palmaris brevis; 23, tendons of the flexors; 24, long Flexor of the thumb; 25, Adductor of the thumb; 26, muscles of the little finger; 27, ligaments binding the tendons; 28, *Brachial Artery;* 29, branches to the coraco-b. and to the biceps; 30, Profunda humeri; 31, branch to the triceps; 32, branch to the brachial and triceps; 33, Anastomotica interna; 34, branch to the brachialis internus; 35, branch to the pronator and palmaris longus; the division into radial and ulnar is seen to take place below the tendon of the biceps; 36, recurrent radial; 37, branches to supinator, &c.; 38, b. to pronator and flexors; 39, the Radial winding beneath the extensors of the thumb, to the back of the hand; 40, 41, branch of R. to index; Volar branch; 42, Ulnar a.; 43, branch to the palmaris brevis; 44, Ulnar, continued, forming superficial palmar arch, by inosculating with the volar branch; 45, branch, (digital,) to little finger, giving off an anastomosing branch; 46, 46, 46, Digital arteries.

2. The second figure represents the arteries of the arm and fore-arm—many of the muscles being removed. No. 1, marks the Coraco-brachial m.; 2, the Triceps; 3, the Brachialis inter.; 4, the short portion of the Triceps; 5, inter. Condyle; 6, Supinator longus; 7, Extensor Carpi radialis longior; 8, Extensor Carpi radialis brevior; 9, tendon of the Biceps; 10, inter-muscular ligament; 11, Inter-osseous ligament; 12, Pronator Quadratus muscle; 13, annular ligament of the wrist; 14, Os pisiforme; 15, Metacarpal bones; 16, *Brachial Artery;* 17, branch to the coraco-brach.; 18, Profunda; 19, branch to the triceps; 20, branch to the triceps; 21, Anastomotic; 22, Radial recurrent; 23, Radial; 24, Ulnar, giving off; 25, the ulnar recurrent; 26, the Inter-osseal; 27, branch of same; 28, same, passing under pronator quadratus; 29, branch of Radial to pronator; 30, muscular branches of Radial; 31, Volar—the Radial, from which it springs, winding round the wrist; 32, branch of Radial entering the palm to inosculate with the ulnar and to form *deep arch;* 33, Ulnar cut off; 34, branch to little finger and muscles; 35, 36, 37, branches from deep arch to inter-osseous muscles, and to inosculate with digital; 38, collateral branch to index; 39, to the thumb; 40, 40, Digital.

3. The last figure represents the deep branches on the posterior part of the Arm. No. 1, the os Humeri; 2, the Brachialis inter. m.; 3, origin of long Supinator; 4, insertion of Triceps; 5, Humero-radial articulation; 6, Coronary ligament; 7, Radius; 8, Interosseous ligament; 9, Ulna; 10, radio-carpal ligament; 11, Profunda Humeri; 12, branch of same; 13, 14, branch inosculating with radial recurrent; 15, Recurrent Interosseal; 16, superior perforating branch of Interosseal; 17, branch of same; 18, inferior perforating branch of Interosseal; 19, branch inosculating with the ulnar and radial, to form vascular net-work on back of hand; 20, Radial; 21, Ulnar; 22, branch of Radial to inosculate with branch of ulnar; 23, branch of Radial passing into palm; 24, dorsal a. of the thumb; 25, external dorsal of the index; 26, 27, 28, posterior Interosseal, terminating in Dorsal arteries of the fingers; 29, internal Dorsal of the little finger.

The Brachial Artery, (Arteria Brachialis,) is the direct continuation of the axillary, and begins where that vessel terminates, at the inferior margin of the tendon of the teres major. It traverses, longitudinally, the whole extent of the arm, and terminates at a finger's breadth below the elbow joint.

The general course of the artery, along the arm, is spiral—very nearly indicated, indeed, by that of the seam of the coat-sleeve, when the arm is extended. Being situated on the inside, at the upper part of the arm, and deeply, it both winds outwardly and becomes more superficial. In its descent, it is first covered *anteriorly* by the coraco-brachial muscle, and the aponeurosis which envelopes the brachial muscles. Below this, it runs along beneath the internal border of the biceps muscle. At the elbow joint, it passes into the interstice between the pronator teres and the supinator longus, and beneath the strong aponeurosis of the biceps, which springs from the tendon of that muscle to pass obliquely inward over the origin of the flexor muscles which arise from the inner condyle. It is also overlapped by the border of the pronator teres. The median basilic vein here crosses its track obliquely, and exterior to this, it has cellular tissue and the integuments.

Posteriorly, the artery, for one-third of its length, rests upon a great quantity of adipose tissue, which, with the muscular spiral nerve, separates it from the triceps; but, lower, it is supported on the brachialis internus muscle. *Internally*, are the brachial vein, and the median nerve.

Externally, the artery, for a third of its course, is in contact with the humerus, the coraco-brachial muscle only intervening for a short distance. Below, it is lodged in the groove between the brachialis internus and the biceps.

In this course, the artery gives origin to numerous branches, hereafter to be described, and at length is resolved, at its termination, into the radial and ulnar. Often, however, this division occurs in the upper region of the humerus, as I shall hereafter describe.

The Brachial Artery gives origin, in its course, to numerous branches destined to supply the parts which constitute the arm. They may be regarded as forming two ranks—an *external*, and an *internal*.

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Brachial Artery. This vessel is peculiarly interesting to the surgeon. There is probably none so obnoxious to injury, and none which is so often the subject of surgical operations. This arises from the exposed situation of the artery, and from the frequent performance of venesection at the bend of the arm, in its immediate vicinity. Even the more remote relations of this vessel, therefore, and those which do not strictly belong to the anatomical description of its course, demand our attention.

The basilic vein sometimes runs along the inner border of the arm, superficially to this artery, and parallel with it, to the axilla. The internal cutaneous nerve bears nearly the same relations. The ulnar nerve is on the inside and behind it, but, low in the arm, is separated from it by the inter-muscular ligament. The median nerve, which I have described as being situated on the inside, is variable in its relations. At the origin of the brachial A. it is on the radial side Sometimes it dips between the artery and the bone. In the bend of the arm, the artery lies closely between the tendon of the biceps and the median nerve, and is firmly bound down by the aponeurosis of the biceps.

The surgery of the region of the bend of the arm being highly important, it is necessary that we should here point out the relations of the artery more minutely. Anteriorly the artery is covered by the integuments,—by the superficial fascia—and partially by that portion of the tendon of the biceps (see No. 8 in the plate) which, passing inward and downward over the artery, is lost in the aponeurosis of the fore-arm. But it is only in the middle part of this region that the artery is protected by this tendon; both above and below its narrow band, its place is occupied by cellular tissue.

Branches of the internal cutaneous nerve are found in front of the artery, and the median basilic vein crosses it obliquely from below upward and inward. Along the inner side of the artery, runs the median nerve, though sometimes behind it. In the upper part of its course, the artery here has the tendon of the biceps on its outer border; but below, the tendon dips to be inserted, and passes obliquely behind the artery. Here it is sometimes adherent to the vessel, and, in consequence, when the fore-arm is strongly pronated, the artery is drawn outward from beneath the median basilic vein.

The *External* branches of the brachial artery, are exceedingly inconstant, in regard to number and order of distribution. Cloquet remarks that there are usually two constant branches which enter the biceps muscle and ramify towards its inferior extremity. Other slender twigs pass in great numbers to the biceps muscle, the coraco-brachial, the brachialis, and the skin. It is because of the close proximity every where, of the organs to be supplied, to the main artery, that the small branches with which they are furnished arise so directly from the parent trunk, and in an order so inconstant.

The *Internal* branches are more numerous and important. Their number is irregular, and their arrangement varying. Several high in the arm, are reflected upon the shoulder and to the axilla—ascending upon the deltoid, or passing along the border of the pectoralis major. Others, at lower points, pass back to the triceps, and following its fasciculi, impart to them numerous twigs. Of these there is one which accompanies the ulnar nerve to the lower part of the arm.

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The most interesting of the relations of the artery is that which it bears to the median basilic vein. The latter vessel, being the most superficial and conspicuous of the veins of this region, is that which is usually selected by the ignorant for phlebotomy, and indeed it is often opened by the well-informed practitioner. I have remarked that the vein obliquely crosses the artery in front; but the point of intersection varies, and so also does the obliquity of the vein. Fortunately, the point where the vein crosses the artery is usually that at which the aponeurotic band from the biceps intervenes between these vessels. But sometimes the place of intersection is below, and then nothing intervenes but cellular tissue. Sometimes the vein crosses the artery almost at right angles, and sometimes it runs nearly parallel with it. In the latter case, it may be coincident with the artery, through the whole of the bend of the arm.

It is manifest that there must be greater danger in performing phlebotomy on that portion of the vein which covers the artery. Even where the aponeurosis intervenes, this membrane may be easily pierced by a keen lancet, or by the forcible thrust of a dull instrument, and the artery wounded. When the tendon does not intervene, the danger is obviously still greater. The prudent surgeon, therefore, will usually avoid the median basilic, and select the median cephalic. On this point M. Dupuytren is very emphatic, declaring that in no case should the median basilic be chosen for phlebotomy. In cases in which no other vein can be raised in either arm, he insists that blood should rather be taken from a vein of the hand or foot. I cannot think, however, that there is any appreciable danger in opening this vein in those cases in which we are able to select a portion of the vessel which is a little removed from the front of the artery, the course of the latter being carefully traced by the finger, after the arm is extended and the ligature applied. Care should be taken, however, that the ligature may not suppress the pulsations of the artery, and thus deceive the practitioner in regard to its presence. I have once known the artery to be wounded in a child, in consequence of this occurrence. The ligature being applied, and the operator feeling no pulsation beneath the most prominent portion of the vein, struck it with the spring lancet. On relaxing the ligature it was discovered that the artery was slightly wounded, the vein having been transfixed. This probably occurred the more readily, because the vein (not receiving blood from the artery) could not have been very firmly distended.

It should always be carefully borne in mind, that, in the fold of the arm, anomalous distributions of the arteries not unfrequently occur. As represented in plate 7, sometimes the radial, arising at some point above the elbow, passes along the fold of the arm, anterior to the tendinous aponeurosis of the biceps, and is as conspicuous as any of the veins of that region. Sometimes the ulnar is equally superficial. Under such circumstances an artery has been known to be opened instead of a vein, not only by the ignorant, but even by the medical practitioner, the pulsation of the vessel not being noticed at the moment. Instances in which injury is inflicted by the lancet on the brachial artery in bleeding, are of frequent occurrence both in this country and in Europe, and frequently give rise to interesting questions in medical jurisprudence. It would appear that, in such a case, no circumstance can fully justify the physician, but some sudden and violent motion of the patient, for it is obviously possible that, in such case, the artery may be wounded, to whatever part of the fold of the arm the lancet may have been addressed. Unusual distributions of arteries and veins can, in my view, furnish no apology, for if arteries are present, and sufficiently superficial to be exposed to the lancet, they can always be felt and avoided; and no operator should ever apply the lancet without carefully searching for the pulsation of

1. The *Profunda Humeri*, (External Collateral Artery,) is one of the internal rank. It is the great muscular artery of the arm; but is not invariably a branch of the brachial;—sometimes it is derived from the posterior circumflex, or even the scapular. When it springs from the B. it is above the inner portion of the triceps extensor, and it insinuates itself into the groove of the bone which conveys the musculo-spiral nerve, and accompanies the nerve, being situated above it. Its course is therefore backward and downward, till it reaches the middle of the posterior part of the arm; then, it passes between the triceps extensor and brachialis internus—reaches the integuments, and is resolved into two branches. One of these is directly continued, and is appropriated to the triceps where inserted into the olecranon. The other branch passses between the brachialis and the parts covering it, and gives numerous twigs to this muscle—to those arising from the external condyle, and to the skin.

The P. before it winds round the humerus, gives twigs to the triceps—some of considerable magnitude. Others, from the same region, pass to the outer portion of the triceps and to its short head; one of these, insinuating itself beneath the muscles, enters an oblique foramen in the bone, becomes the nutrient artery of the humerus, and ramifies on the medullary membrane.

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arteries. There is no danger (in regard to arteries) in striking a vein beneath which no pulsation can be felt, provided the ligature be not so tightly drawn as to arrest pulsation at the wrist.

When the brachial artery has been pierced in phlebotomy, the wound being small, longitudinal, and of but small extent externally, there may sometimes occur complete re-union in a brief space of time; but usually there will be formed, beneath the brachial fascia, a circumscribed traumatic aneurism, presenting itself in the form of a firm hemispheroidal tumour, slowly increasing. At other times the tumour will be more diffused, the blood insinuating itself along the sheath of the artery upward upon the arm. If the artery be wounded immediately below the border of the tendinous band of the biceps, the aneurism which forms will extend downward and outward. Its extension upward and inward will be hindered by the band. In operating on such an aneurism we expect to find the wound in the artery higher than the centre of the tumour. When the artery is wounded where overspread by the aponeurotic band of the biceps, the tumour will be resisted in its expansion, and will for a long time remain flattened. If the vessel be wounded still higher in the bend of the arm, the tumour will extend upward, inward, and forward.

Immediately after the infliction of such a wound, and while perhaps blood is still effused at the external orifice, the diffusion of that fluid rapidly taking place in the arm, and it is yet impossible to determine where it may be arrested, the surgeon will generally prefer to cut at once for the artery, at the place of injury—to discharge the effused blood, and to secure the vessel both above and below. Harrison, Colles, and other surgeons, appear to confide in the single ligature, applied above the seat of the injury. This practice is more applicable, however, and very generally adopted, in those cases in which the rapid diffusion has been arrested, and, from the lapse of some time, the aneurism has become distinctly formed. In such instances the aneurism is not unfrequently resolved by medical means, and by pressure firmly made upon the tumour. The disease usually occurring in a healthy artery, the recuperative efforts are often successful, when judiciously aided by bleeding, repose, and the bandage. The peculiar anatomical relations of the vessel contribute to this result, which is not observed to take place with equal facility in the large arteries of other regions. Such, then, being often the result of these means, we should anticipate that the single ligature would succeed in almost all cases. This operation is practised with success, as I learn from the journals, in the Parisian hospitals. Dupuytren, however, remarks, that although the ligature, thus applied, arrests pulsation in simple aneurisms, it does not produce that effect on veno-arterial aneurisms.

When the vein is transfixed and the artery pierced, so directly that these vessels retain their relations till they become adherent, blood rushes from the artery into the vein, forcibly distending it, and forming aneurismal varix. But often the walls of the short passage, which leads from the artery to the vein, will become distended in the form of a cyst, and thus constitute a complex disease, termed *varicose aneurism*.

The following are the methods of performing the ligature of the brachial artery:

1. If the operator would secure the vessel near its origin, let him extend the arm, supinate the hand, and make an incision two or more inches long, by the ulnar side of the coraco-brachial muscle. The internal cutaneous nerve and

Often there is a second profunda, arising at the distance of two inches below the former, and assuming the direction and relations of one of the branches above described.

2. The *Anastomotic Branch*, (Anastomotica Magna.) This considerable branch springs from the brachial above the inner condyle. It inclines inward, before the brachialis muscle, and crosses behind the median nerve. It then pierces the inter-muscular ligament, which separates the brachialis internus from the border of the triceps extensor. It is then resolved into two twigs. One of these pursues the inner border of the humerus to the condyle—then subdivides and inosculates with the anterior ulnar recurrent. A twig from this branch also seeks the groove between the olecranon and inner condyle, and passes to the fore-arm with the ulnar nerve. The second branch passes backward, into the fossa olecranoidea, gives twigs to the termination of the triceps, and anastomoses with the posterior ulnar recurrent. The anastomotic gives numerous irregular branches to all the organs which it approaches in its course; their particular description would be as useless as impracticable.

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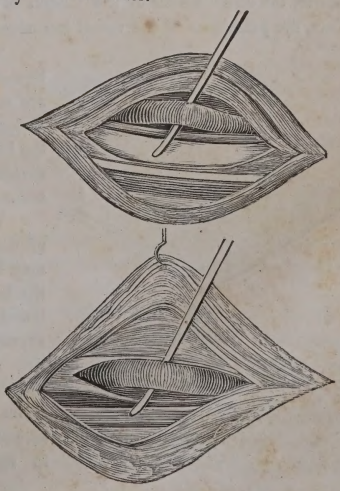
the basilic vein, sometimes present, must be avoided. The artery and veins are thus exposed, lying between the median nerve, on the radial side, and the ulnar, within. The operator should be exceedingly cautious in identifying the artery. Sometimes, as Mr. Harrison remarks, it does not distinctly pulsate, and hence the median nerve may be included instead of it. If the vessel be gently held between the finger and thumb, and then the arm be suffered to repose a moment, the pulsation will be manifest. By pressure upon the vessel, also, pulsation ceases in the aneurism, and in the branches of the artery. These precepts will not be considered as superfluous, when it is remembered that an operator no less celebrated than M. Roux, recently drew a ligature upon the median nerve, instead of the brachial artery.

2. If the B. A. be sought near the middle of the arm, the vessel is easily approached by an incision along the ulnar border of the biceps, through the integuments and fascia of the arm. The median nerve is then usually encountered on the inner side and in front of the artery. The vessel is then brought into view, associated with the brachial veins, (usually two,) from which it is to be cautiously separated.

3. When the artery is sought in the upper part of the bend of the arm, it is found by dividing the superficial fascia between the ulnar border of the tendon of the biceps, and the outer border of the eminence formed by the muscles arising from the olecranon and inner condyle. If it be sought at a lower point, and where covered by the aponeurotic band of the biceps, the band must be divided. If it be cut for still lower, the incision is directed in a similar manner, but extended lower. The artery, nerve, and vein are there in close proximity to each other.

The accompanying cuts illustrate the operations upon the brachial artery. The first exhibits the operation on the artery above the elbow —the second in the fold of the arm. In the first, the external border of the incision is that of the skin. The border of membrane seen within this is that of the superficial fascia. The artery is seen raised from the sheath common to it and the nerve and veins. Contiguous to the artery, above and below, are small venæ comites. Below the latter, the median nerve is conspicuous. Still lower is the cutaneous nerve, and still below this the brachial vein.

In the second cut are seen—first the border of the integuments, then that of the superficial aponeurosis. The artery is seen raised from its sheath. Above it is a portion of the brachialis muscle. A vein accompanies the artery below, and still lower is seen the median nerve.



Sometimes there is present a lesser anastomotic, arising lower, and then taking the place of one of the branches which we have described.

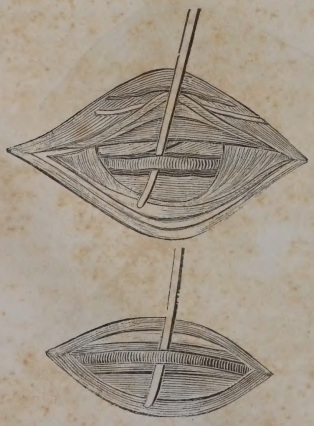
At the point already named, usually a finger's breadth below the elbow joint, and where the tendon of the biceps sinks between the muscles of the fore-arm, the brachial artery is resolved into its two terminal branches; 1, the *radial;* 2, the *ulnar.* It is by no means unfrequently the fact, however, that this division occurs at a much higher point—sometimes, indeed, in the axilla, but oftener a little above the middle of the arm. An intelligent teacher of anatomy informs me that he has seen it thus in nearly half the instances in which he has dissected this region. From my own observation, I should infer that this early division might occur in one individual of eight or ten. When such is the arrangement, the ulnar usually pursues the ordinary course of the brachial, but the radial diverges a little externally from it, and is more superficial, being in some rare instances exterior to the aponeurosis of the biceps, and distinctly felt beneath the integuments.

1. The Radial Artery, (*Arteria Radialis,*) is directly continued from the brachial, but is smaller than the ulnar, and more superficial. Soon after its origin, it inclines a little outward, to gain the radial side of the fore-arm. Its course is then very direct, to near the root of the metacarpal bone of the thumb. Then it abruptly changes its course, and winds spirally around the outer border of the carpus, beneath the extensor tendons of the thumb, and descending a brief distance, sinks between the heads of the metacarpal bones of the thumb and index, and is there resolved into three branches.

SURGICAL OBSERVATIONS.

Radial Artery. This vessel occupies a much more exposed situation than do most arteries of its magnitude. It is, therefore, often the seat of troublesome traumatic hemorrhage, and of traumatic aneurism; hence it is the frequent subject of surgical operations. It may be exposed with facility in any part of its course. In the upper third of its length, the R. A. may be approached by an incision three inches in length, made along the ulnar border of the supinator longus, which is a little on the radial side of the middle of the fore-arm. The basilic vein is to be avoided—the fascia to be divided—the supinator to be gently separated from the pronator teres. The fascia which binds down the artery is now to be divided, and the artery and veins are then exposed.

When sought in the middle of its course, it may be exposed by a similar incision, two inches in length, on the ulnar border of the supinator. The spiral nerve is here close to the radial side of the vessel. In the inferior third of its course, the outer border of the tendon of the extensor radialis is our conspicuous guide. But in both the lower sections, the pulsations of the vessel can usually be felt.



The first engraving shows the mode of exposing the radial artery for the ligature high in the left fore-arm. The artery is seen raised;—the venæ comites are seen one upon the each side of it. Below the vessels is seen the tendon of flexor sublimis; above them—the tendon of the pronator teres; the tendon of the long supinator still above this. The fascia which enveloped all these is seen divided and reflected. A superficial vein and nerve are seen exterior to it. The second shows the mode of exposing the vessel at the wrist.

Where the R. A. winds round the carpus, it is buried beneath the extensors of the thumb; but it becomes accessible again on the dorsum of the hand, and may be readily exposed by an incision an inch long, drawn directly between the heads of the metacarpal bones of the thumb and index. It is there usually found associated with two veins. I have had occasion to cut for it there, and secured it with great facility.

Ulnar Artery. Where the U. A. lies deeply buried among the flexor and pronator muscles, in the most fleshy part of the fore-arm, it may be regarded as inaccessible, unless exposed by an accidental wound. In the middle of the fore-arm, it may be readily exposed by an incision two inches and a half in length, along the radial border of the flexor carpi ulnaris. The fascia

The radial, in its descent upon the fore-arm, is invested externally only by the integuments—the aponeurosis of the fore-arm, and by an aponeurotic sheath which it borrows from contiguous muscles, and which embraces the artery and its accompanying veins and nerve; it is particularly strong near the wrist. In the upper third of its course, the R. lies deep in the fissure between the supinator radii longus, on the outside, and the pronator teres, within. Indeed, these organs, especially when large, overlay and conceal the artery, which, however, may be easily exposed by gently separating the muscles. As the artery descends along the middle third of its course, it still bears the same relation to the supinator and its tendon, which slightly overlaps it; but on the ulnar side, it now has the border of the flexor carpi radialis and its tendon. It retains the same relations to the tendons of these muscles, till it commences its spiral turn at the wrist.

In the upper section of its course, the R. lies upon the tendon of the biceps, embedded in loose tissue, and crossing several filaments of the spiral nerve which lie between it and the supinator brevis. A little above the middle of the fore-arm, it crosses obliquely the insertion of the pronator teres, and rests on the radial origin of the flexor sublimis. In the lower third of the fore-arm, it lies upon the flexor of the thumb, the pronator quadratus, and finally on the radius itself. In its spiral turn around the wrist, it is sustained upon the capsula and lateral ligaments, and on the head of the first metacarpal bone. Often the R. commences its spiral turn one, two, or three inches above the usual point, and then descends along the dorsum of the radius and corpus, to its point of termination. It is resolved into its terminal branches deep behind the abductor indicis, and adductor pollicis.

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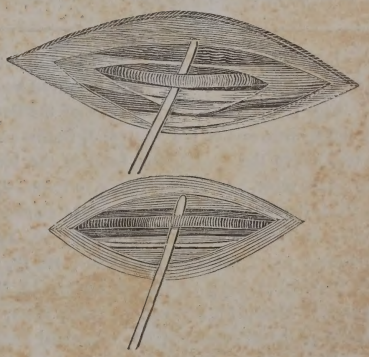
of the arm is to be divided, and flexor carpi to be separated from the flexor sublimis, (for these muscles collapse over the artery) the deep fascia which binds down the artery is then to be incised, and the artery, with its venæ comites, is exposed. These, which are on each side, and the ulnar nerve which is on the ulnar side, are to be avoided in passing the ligature. Near the wrist, the vessel is secured in the same manner, with still greater facility.



The first cut exhibits the ulnar artery exposed for the ligature high in the fore-arm. The sheath which envelopes the artery, ulnar nerve and vein is seen opened longitudinally—the nerve below, a vein above. The flexor sublimis is seen above the vessels and nerve,—the flexor carp. ulnaris below. The aponeurosis is also seen.

The second shows the vessel exposed at the wrist.

There are but few regions of the body that are more vascular, or that derive their arteries from a greater number of trunks than the palm of the hand. It is furnished, not only with its nutrient vessels, but it transmits the numerous, considerable branches which pass to the fingers. The soft parts of the palm being chiefly composed of tendons, the firm palmar aponeurosis, very dense cellular tissue and integuments, it results that when even a small arterial branch in this region is wounded, it can neither promptly retract, nor deposite in its sheath an external coagulum. Hence will the hemorrhage which occurs rarely cease spontaneously, till alarming consequences result. This is also in a degree owing to the very free anastomosis which the three arteries supplying the palm enjoy with each other, in consequence of which the wounded vessel bleeds at both orifices.

The management of wounds of the palm, in regard to hemorrhage, is attended with peculiar difficulties. Mr. Harrison remarks that, when such a wound is searched for the bleeding vessel, blood is found to flow from many minute orifices, and no particular artery can be fixed upon as the source of mischief. Closing the wound will not suppress the hemorrhage; and deeper incisions, for the purpose of exposing a larger vessel, will but increase the difficulty. When the surgeon cannot promptly fix upon a particular artery, which is the principal source of hemorrhage, he should resort at once to pressure with the graduated compress, which, from the firmness of the parts, may here be used with advantage. Effectual compression is sometimes made in the palm of the hand by placing a wooden ball an inch and a half in

The R. in nearly its whole course, has usually an accompanying vein on each side of it. In the upper section of its course, the spiral nerve is at a little distance, on its radial aspect; lower, it approaches the artery more closely, but winds around the radius at some distance above that vessel.

In the course above described, the radial artery gives origin to the following branches:

1. The *Radial Recurrent*, (Recurrens Radialis,) an artery of considerable magnitude, arises from the R. very near its origin, on the short supinator. It abruptly turns outward, then upward, ascends before the external condyle, between the supinator long. and the brachialis m. and inosculates with that branch of the profunda which accompanies the spiral nerve. In this course, the R. R. furnishes a tissue of twigs which envelope the joint and supply contiguous muscles.

In its descent along the fore-arm, the R. supplies many small anomalous twigs to the contiguous muscles, nerves, fasciæ, &c. among which are seen, in the plate, branches to the pronator teres—to the supinator—to the flexor communis, and to the pronator quadratus.

2. The *Volar Branch*, (Superficialis Volæ,) is the next considerable artery. It springs from the R. where it rests on the radius, and just before it begins its spiral turn. In regard to direction, it is the R. continued to the palm. Indeed, the main trunk is sometimes thus continued in place of the volar, and only a branch is sent round the wrist. The V. as usually arising, passes downward and a little inward, over the annular ligament, and over the origins of the short muscles of the thumb, sending many twigs into the interstices of those muscles and to the integuments, and terminates in a superficial twig which bends outward, and, anastomosing with the ulnar, completes the superficial palmar arch. When the radial itself thus descends, it contributes largely to the palmar arch, and sends a digital branch to the thumb or finger.

Immediately before it winds round the wrist, and near the last, the R. gives origin to a small branch which supplies the tendons and ligaments in front of the carpus—hence often termed *anterior carpi radialis*. It inosculates with the ulnar and the interosseal.

3. When it has reached the back of the carpus, the R. gives origin to a larger branch termed the *dorsalis carpi radialis*. It traverses the back of the carpus beneath the extensor tendons, supplying the carpal

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Index to Plate VIII. Fig. 1 is introduced to illustrate the usual anatomical relations of the brachial artery in the bend of the arm. Fig. 2 and 3 exhibit anomalous arrangements which occasionally occur in that region.

Fig. 1. No. 1 marks the trunk of the Basalic Vein; 2, Cephalic Vein, separated from the musculo-cutaneous nerve by the aponeurosis of the arm; 3, 3, Basilic and Cephalic Veins of the fore-arm; 4, Director passed beneath the Brachial Artery above the aponeurotic band of the biceps; 5, common Median Vein, which is seen sending a short branch to the deep veins, and then dividing to form—a, the Median Cephalic, and b, the Median Basilic; 6, Posterior Ulnar Vein; 7, Post. Radial; 8, Trunk of Internal Cutaneous Nerve on the inside of basilic vein; 9, Musculo-cutaneous Nerve distributing itself around the median vein; 10, Aponeurotic Band passing from the tendon of the biceps to the fascia of the fore-arm; 11, Tendon of the Biceps; 12, 12, Circumference of an aponeurotic opening existing at the fold of the arm; 13, Brachial Artery; 14, Radial Artery; 15, Ulnar Artery; 16, Median Nerve; 17, Brachial Vein; 18, 20, 20, External Muscular Mass; 19, Internal Muscular Mass; 21, Internal Eminence of the Elbow; 22, Hook which draws inward the border of the aponeurosis; 23, Superficial Fascia and Skin; 24, Fore-arm; 25, Arm.

Fig. 2. No. 1, Biceps Flexor; 2, Long head of Triceps; 3, Short head of Triceps; 4, Brachialis Internus; 5, broad Tendon of the Biceps; 6, long Tendon of the Biceps; 7, Supinator Longus; 8, Pronator Teres; 9, Flexor Radialis; 10, Palmaris Longus; 11, Flexor Ulnaris; 12, Inner Condyle; 13 Intermuscular Ligament; 14, High division of the Axillary Artery; 15, Radial Artery; 16, Ulnar Artery; 17, Profunda Sup.; 18, Anastomotica.

Fig. 3. No. 1, Biceps; 2, Its broad tendon; 3, Long head of the Triceps; 4, Short head of the Triceps; 5, Coraco-Brachialis; 6, Brachialis Internus; 7, Supinator; 8, Extensor Rad. Longior; 9, Pronator Teres; 10, Flexor Radialis; 11, Palmaris Longus; 12, Flexor Ulnaris; 13, Flexor Dig. Sublimis; 14, Flexor Long. Pollicis; 15, Intermuscular ligament; 16, Internal Condyle; 17, Brachial Artery; 18, Radial Artery; 19, Ulnar Artery; 20, Anastomotica; 21, Branch to the Internal Condyle; 22, Radial recurrent; 23, origin of the Interosseous Artery; 24, Interosseous Artery; 25, Radial continued; 26, Ulnar continued.

Pl. 8.

Drawn on Stone by S. Smith.

C.G. Willig's Lith.

articulations, anastomosing with a corresponding ulnar branch. It also sends reflected twigs to inosculate with interosseal branches Sometimes the dorsal gives off a *metacarpal twig*, (dorsalis metacarpi,); sometimes this comes directly from the radial. Occasionally the dorsal arises from a higher point on the R. and winds round the radius.

The dorsalis pollicis is a small branch of the R. given off near its termination, and going to the back of the thumb—being resolved into two branches, one of which passes along the radial, and the other the ulnar border of the thumb. The latter often gives a twig to the radial border of the index. The R. is now resolved into its terminal branches.

4. The *Magna Pollicis*, or *Collateral Artery of the thumb*, is the first of these. It skirts the ulnar side of the metacarpal bone of the thumb, between the abductor of the finger; and the adductor of the thumb. At the first joint, it divides into two branches, which pass along the opposite margins of the thumb, and, near its extremity, converge and anastomose by numerous twigs, forming a complex tissue in the cellular texture and integuments.

5. The *Radialis Indicis* skirts the radial border of the index. It anastomoses with the last described, and with the superficial palmar arch, and then, being continued to the apex of the finger, divides, subdivides, and forms an anastomosing net-work with the digital artery of the opposite border, giving twigs to the integuments and cellular tissue.

6. The *Deep Palmar*, (Palmaris Profunda,) the last of the terminal branches of the R. seeks the palm of the hand between the metacarpal bones of the thumb and finger. It then arches transversely across the upper part of the metacarpus, and beneath the flexor tendons and lumbricales muscles. On the inner border of the metacarpus it inosculates with a deep communicating branch of the ulnar. From the convex side of the *deep arch* thus formed, and which presents toward the fingers, four or five twigs are sent to the interossei muscles, and anastomose with the digital from the superficial arch.

2. The Ulnar Artery, (*Arteria Ulnaris*,) is a larger vessel than the radial. Its general course is along the anterior and inner part of the fore-arm, and its principal destination is to the hand. From its point of origin, it descends obliquely inward, approaching the ulnar border, and insinuating itself between the two layers of superficial and deep muscles of the anterior part of the fore-arm, arising from the internal condyle of the humerus. It emerges from these muscles, which it decussates obliquely, at the middle of the fore-arm, and then becomes vertical. It is here found situated between the flexor sublimis on the radial aspect, and the flexor ulnaris on the inner side. It holds this direction as far as to the pisiform bone, being quite superficial in the wrist. It passes over the annular ligament of the wrist, and then bends abruptly outward, to form, in the palm of the hand, the superficial palmar arch. The course of the ulnar artery to the wrist, is less direct than that of the radial. At the upper part it describes a curve, the convexity of which presents backward and inward. Below, it is also a little flexuous.

Anteriorly, the U. A. is covered, in the upper part of the fore-arm, by the superficial flexor and pronator muscles; along the middle and inferior third of its course, it is covered merely by the integuments, common fascia, and by a fascia which unites the contiguous borders of the flexor digitorum and the flexor ulnaris.

SURGICAL OBSERVATIONS.

diameter in the grasp of the patient, and binding the hand firmly upon it. Should this expedient fail and the hemorrhage continue with alarming pertinacity, there is no alternative but to tie one or both of the larger arteries of the fore-arm. The selection of that to be secured will depend upon the seat of the wound. If it be near the ulnar margin of the palm, then is the ulnar artery amenable. But if it be near the radial border, and at the root of the thumb or index, and if pressure upon the radial command the hemorrhage, then is the latter vessel to be secured in the wrist. But the inosculations being extremely free, and the wound being near the middle of the palm, the ligature of one of these vessels may but temporarily, or partially, arrest the flow; and then, if compression does effect the object, both vessels may be tied, without much danger of causing the death of the hand, because of the free inosculations of the interosseal.

In the middle of the fore-arm, however, the muscles, between which the artery lies, close over it. In the wrist, its pulsation can usually be distinctly felt. In the palm, the arch is covered by the integuments and the strong palmar aponeurosis.

The course of the palmar arch is nearly coincident with the superior of the two wrinkles seen in the palm of the hand when slightly bent,—terminating near the middle of the metacarpal bone of the index. The convexity of the arch presents towards the root of the little finger—its concavity towards the muscles of the thumb. This arch is nearer to the fingers than the arcus profundus, and is more oblique. Associated with the superficial arch, there is a large branch of the median nerve, which, uniting with a branch of the ulnar, forms an arch behind that of the arteries.

Posteriorly, the U. A. at its origin, rests on the brachialis muscle. In the rest of its course, on the fore-arm, it lies on the flexor profundus and the pronator quadratus. At the wrist, it traverses the annular ligament; and in the palm the arterial arch crosses and rests upon the flexor tendon of the fingers.

The U. A. has two venæ comites. The median nerve is associated with it at its origin, but where the artery plunges beneath the muscles, it leaves the vessel and perforates the pronator teres. Where the artery emerges from between the muscles, the ulnar nerve joins it and passes with it to the hand. In the fore-arm, the nerve is on the ulnar side; on the annular ligament, it is rather behind the vessel.

The U. A. before it reaches the hand, gives origin to some important branches, of which the first is—

1. The *Anterior Ulnar Recurrent*, (Recurrens Ulnaris Antica.) This vessel springs from its parent trunk on the inner side, close to its origin. First, it passes downward and outward, between the brachialis and the pronator teres muscles. It then bends upwards, in front of the internal condyle, and inosculates with the anastomotica.

2. The *Posterior Ulnar Recurrent*, (Recurrens Ulnaris Postica,) arises near to the origin of the last, or by a common trunk with it. It is larger than its fellow. It passes downward and inward behind the pronator teres, the flexor radialis, and the flexor sublimis, and in front of the flexor profundus. Then it winds upward, behind the inner condyle, and insinuates itself between this eminence and the olecranon. It is there lodged beside the ulnar nerve—it passes between the two origins of the flexor capri ulnaris, and anastomoses with the profunda and the anastomotic. It gives twigs to all the muscles which it approaches, and to the joint.

Below the origin of the recurrent, the U. A. sends small inconstant twigs to neighbouring muscles. A little below the tubercle of the radius, and about an inch and a half from the origin of the U. the most considerable of its branches, the *interosseal*, takes its origin. In conformity with general usage, I shall describe this vessel after having completed the description of the ulnar and its rami—regarding it as an independent trunk.

As it approaches the inferior extremity of the ulna, the U. A. sends one small twig to the front of the carpus, and another to the dorsum;—they are termed *carpi ulnares*. As it passes over the annular ligament, on the inside of the pisiform bone, the U. A. sends twigs to the cellular tissue and integuments. Opposite the base of the metacarpal bone of the little finger, it gives origin to the—

3. *Deep Palmar Branch of the Ulnar*, (A. Palmaris Profunda Ulnaris.) This branch passes backward, between the flexor brevis and abductor of the little finger, giving twigs to them, and then inosculating with the deep palmar of the radial, to complete the *deep palmar arch*.

The concavity of the *superficial palmar arch* formed by the ulnar, gives off but few twigs—these it imparts to the lumbrical muscles, and to the annular ligaments. From the convex side, toward the fingers, four, sometimes five, considerable branches take their origin.

4. 5. 6. 7. 8. The *Digital Arteries*. (Collateral Arteries of Cloquet.) The first of these directs itself downward and inward, on the muscles of the little finger, imparting twigs to them, and decussating them at right angles. It then skirts the inner margin of the little finger, and passes to its extremity. The other four branches are given off at nearly equi-distant points, and correspond to the interosseous spaces. They

descend to the inferior extremities of the metacarpal bones, and are each resolved into two twigs which run along the corresponding edges of the four fingers and the inner margin of the thumb. Near the middle of the last phalanx of each finger, the arteries of opposite borders converge, enlarge a little, and inosculate; from this arch, numerous ramuli arise to form a beautiful tissue over the ends of the fingers, and, with the digital nerves, are wrought into the papillæ of these regions. As they descend, these arteries give off twigs which wind round the phalanges, inosculating before and behind with corresponding twigs, and supply the joints, sheaths of the tendons, &c. Before they coalesce, at the points of the fingers, they give origin to twigs which encircle the roots of the nails, and form vascular tissues beneath them. From the palmar arch of nerves, described above, digital filaments arise to accompany the digital arteries. Opposite each interstice between the fingers, the digital artery perforates the nerve, and as they descend on the border of the finger, the nerve is the more superficial.

Not unfrequently it happens that there is no distinct arch formed in the palm. The U. A. in its descent inclines a little inward, and is abruptly resolved, at acute angles, into branches, which, by sub-division, become the *digital.*

The Interosseal Artery, (Arteria Interossea.) This vessel arising as has been described above, descends, inclining backward and a little outward and seeking the interosseous space. In this section of its course, it gives off a few twigs termed *anterior recurrent*, which ascend toward the coronoid process and inosculate with the other articular arteries. At the upper edge of the interosseous ligament, the I. A. is resolved into two branches, the *anterior*, and the *posterior interosseal.* The *anterior*, the continued trunk, insinuates itself between the surface of the interosseous ligament, and the *flexor profundus* muscle, and together with a branch of the median nerve, descends till it encounters the border of the pronator quadratus. Here it is resolved into two branches, one for the pronator muscle, and another which descends in front of the carpus, and anastomoses with carpal branches of the radial and ulnar arteries. The other twig pierces the ligament—descends behind it, and behind the radius, and terminates in ramuli which inosculate freely with the *posterior interosseal*, and with the posterior carpal artery.

The *Posterior Interosseal*, passing through the interosseous space above the margin of the ligament, is there invested posteriorly by the anconeus and the extensor communis muscles, and is usually resolved into two branches. One of these ascends and is usually termed the *interosseal recurrent.* It winds between the anconeous and the supinator brevis muscles, and ascends to the arm between the olecranon and the internal condyle. It inosculates freely with the recurrent radial, and with the profunda;—it also sends, toward the olecranon twigs which inosculate with those of the recurrent ulnar. The descending branch of the P. I. diverges a little from the interosseous ligament, and passes among the fasciculi of the extensor communis and the extensor of the thumb. Near the carpus it is resolved into branches, of which some anastomose with the posterior branch of the anterior interosseal—some with the dorsalis carpi radialis—others with the carpi ulnaris.

INTEROSSEAL ARTERY.

Interosseal Artery. This vessel is so deeply lodged between the bones of the fore-arm, that it is rarely wounded, and never cut for, unless in enlarging a wound by which it is opened. In regard to amputation of the fore-arm, however, its anatomical relations render it interesting. The anterior branch especially is so close to the interosseous ligament, that when it retracts after being divided, it conceals itself above the divided margin of the ligament. It ought always to be sought for and secured. It will be found nearer to the radius than the ulna.

The abundant inosculations of the recurrent radial, ulnar, and interosseal arteries, with the profunda and anastomotic around the elbow joint, furnish sufficient channels for the prompt establishment of the collateral circulation, in all cases of obliteration of the lower portion of the brachial artery, either by wounds—by disease—or by ligature.

SECTION III.

ARTERIES OF THE THORAX AND ABDOMEN.

The Thoracic Aorta, (Aorta Thoracica Descendens.) From the point at which the arch of the aorta terminates, this great trunk, having completed its curve, reversed its direction, and become vertical, descends through the thorax to give branches to it, and to seek the inferior regions of the body. As it proceeds, it rests obliquely on the left and in front of the dorsal vertebra, below the third, inclining a little from the left to the front of the spine. On reaching the diaphragm, it finds a foramen, designed for its transmission, formed by the decussating pillars of that muscle. On entering the abdomen, it becomes the *abdominal aorta.* In its descent, the thoracic aorta is lodged between the laminæ of the posterior mediastinum. In front of it, a little on its right above, but gaining the left in its descent, is situated the œsophagus; and exterior to both, is the pleura of the left side, more closely adherent to the aorta. On the right it has the vena azygos, and, in the interstice behind and between the artery and the veins, is lodged the thoracic duct. This vessel passes with it into the abdomen. At the beginning of its course, the T. A. has the bronchi and œsophagus in front—lower, it is bounded anteriorly by the pericardium. The pneumogastric nerves, following the œsophagus, bear the same relation to the artery as does that tube. The splanchnic nerves pass obliquely forward from the intercostal spaces, into the posterior mediastinum, and in the lower region are situated on each side of the aorta. The left intercostal veins cross the spine behind the aorta, to reach the vena azygos.

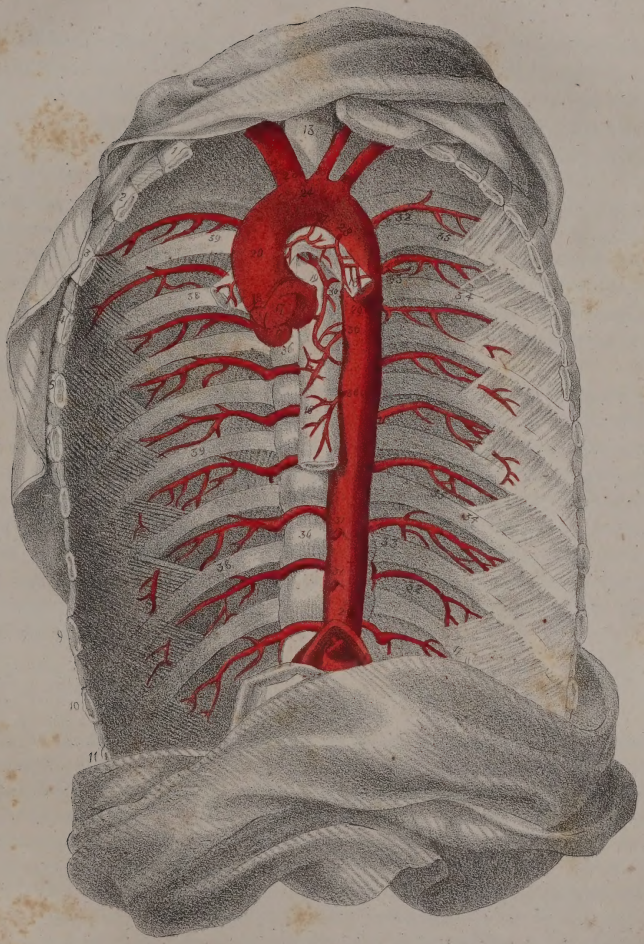
Branches which arise from the Thoracic Aorta.

1. The *Bronchial Arteries*, (Arteriæ Bronchiales.) These small vessels are usually two, *right* and *left*, though often four in number—two on each side, superior and inferior. Sometimes a single trunk is the root of all the bronchial twigs.

The *right* B. A. arises often from the aorta, opposite the fifth or sixth dorsal vertebra, but more frequently from the right superior intercostal—sometimes from the internal mammary. From its place of origin, after giving twigs to the œsophagus, it meanders outward along the posterior surface of the bronchus. In this course it gives twigs to the pleura, the pericardium, and to the bronchial glands. On reaching the lung it divides and sub-divides in correspondence with the divisions of the bronchi, and its branches are lost among the lobes and lobuli of the lungs. Usually there are two or three twigs to each bronchial tube, and around this they form a fine net-work which gives most of its terminal ramuli to the bronchial membrane, but some of them to the parenchyma of the lung. The *left bronchial* corresponds, in its relations, to the right, except that it more generally arises from the aorta.

The B. A. are commonly regarded as performing the office of nutrient vessels to the lungs; but their magnitude seems scarcely adequate to that function. Ruysch asserts that they inosculate freely with the pulmonary artery. The latter vessel can be injected from them with facility. They appear also to communicate with the pulmonary veins.

Index to Plate IX.—No. 1 to 11, section of the Ribs and Intercostals; 12, Crura of the Diaphragm; 13, Trachea; 14, 15, Bronchi; 16, Œsophagus; 17, Semilunar Valves of the Aorta; 18, 19, Coronary Arteries; 20, 21, Aorta; 22, Innominata; 25, left Carotid; 26, left Subclavian; 27, 28, Bronchial Arteries; 29, Aorta, passing from the Thorax; 30, Œsophageal Arteries; 31, 31, branches to the Œsophagus and Mediastinum; 32, 32, Intercostal Arteries; 33, 33, Dorsal branches of Intercostal; 34, 34, Ribs and posterior layer of Intercostal Muscles; 35, 35, inferior branch of proper Intercostal, passing to margin of inferior rib; 36, Vertebræ; 37, 37, right Intercostals, wrapped around the spine; 38, 38, Ribs of the right side; 39, inferior branch of right Intercostal.



Drawn on Stone by S. Smith.

G. Willis Lith.

2. The *Œsophageal Arteries*, (Arteriæ Œsophageæ,) are of the size of the bronchia. They arise irregularly (from two to six in number) from that part of the A. which rests onthe sixth, seventh, and eighth dorsal vertebræ. At their origins they give twigs to the pleuræ, and to the cellular tissue of the mediastinum. They then bend to the right and downward, and reach the muscular tunic of the œsophagus in which they minutely ramify. The lower twigs anastomose with those of the coronary artery of the stomach.

3. The *Posterior Mediastinal Arteries*, are minute ramuli which, in a variable number and order, arise in part from the anterior side of the aorta, below the last described; and in part from the œsophageal and intercostal arteries. They form a delicate tissue around the aorta, and impart to it the vasa vasorum.

4. The *Aortic Intercostal Arteries*, (A. Intercostales Inferiores.) Of these there are commonly nine, corresponding to the nine inferior intercostal spaces. Sometimes, however, they are eight, and sometimes ten in number, according to the number of spaces supplied by the *superior intercostal.* They arise on each side from the posterior and lateral aspects of the parent trunk, at angles somewhat acute, and then pass obliquely upward, backward, and outward, in grooves which traverse the sides of the vertebræ. The obliquity of the uppermost intercostal is greatest;—the inferior branches are transverse with respect to the aorta. The right intercostals are necessarily longer than the left, inasmuch as the parent trunk is situated on the left of the spine; they more than half encircle the bodies of the vertebræ, and are covered anteriorly by the œsophagus, the thoracic duct, and the sympathetic nerve. Those of the left are covered only by the pleura and the sympathetic nerve.

Near the costo-vertebral articulation, where each artery is entering the space between the ribs to which it is appropriated, the intercostal is resolved into two branches—a *posterior*, or *dorsal*, and an *anterior*, or *proper intercostal.* The dorsal passes backward between the transverse processes of the contiguous vertebræ; and on the inner side of the inferior costo-transverse ligament. It imparts a few twigs to the bodies of the vertebræ, and others it furnishes, which, above and below, inosculate with the adjacent intercostals. It also furnishes a twig which enters the intervertebral foramen, and passes to the spinal marrow and its membranes. The dorsal A. then plunges among the transverso-spinal muscles—sends branches downward, between them and the longissimus dorsi, to the sacro-lumbalis—others to muscles of the back and to the integuments. The superior branch sends upwards, along the muscles of the spine, long twigs, which inosculate with subclavian branches around the scapula.

THORACIC AORTA.

The *Thoracic Aorta.* This great vessel is not unfrequently the seat of aneurism. It lies buried so deeply from the eye and hand of the surgeon, that the general traits which characterize aneurism are here not to be observed. Our diagnostic criteria must take their character from the relative anatomy of this vessel—the disturbance of function which must be produced in adjacent organs in the progress of the disease. From the local relation of the œsophagus to the diseased organ, impeded deglutition must result—also, dyspeptic disorder of the stomach from pressure on the eighth pair of nerves. I have known this to be the most distressing symptom of the affection. The tumour being situated behind the heart, will, if it tend forward, mechanically interfere with the circulation, creating malposition of the heart, palpitation, pain, and sense of fullness, and other signs of disease of that organ. If the development be to the right or left, the lungs suffer, and symptoms of phthisis result, except that the expectoration is thin and frothy; whereas, in phthisis, it is viscid mucus, or pus. When the tumour urges itself backward upon the spine, causing caries of that structure, and irritation of the medulla and its membranes, then is there a sense of weakness and pain in that region—in the superior extremities, and in the respiratory apparatus. The tumour may so protrude the integuments on the sides of the spine, that the disease shall present the appearance of an abscess. The pulse in the lower regions of the body will, for obvious reasons, be aneurismal, and for the most part feeble, while in the superior it will be unusually strong.

Aneurism of the T. A. may burst into the œsophagus, (a frequent result,) into the mediastinum, into the pleura, (especially the left,) or into the lung.

The *Anterior*, or *Proper Intercostal*, is the continued trunk both in regard to size and direction. It is produced directly outward to the middle of the intercostal space, between the pleura and intercostal muscles. In this part of its course, the artery is lodged behind the jutting inferior margin of the superior rib, which thus forms a groove for its reception. It is enveloped in a quantity of loose cellular tissue. The artery preserves this course as far as to the middle of the rib, giving twigs to the intercostal muscle—to the pleura, and to the external muscles of the thorax. The latter anastomose with the thoracic arteries. The I. A. is then resolved into two branches—an *inferior* and a *superior*. The inferior seeks the superior margin of the inferior rib, and is resolved into numerous twigs to the rib and intercostal muscles. The *superior* preserves its former direction and relations; it, however, insinuates itself between the external and internal intercostal muscles. At length it approaches the cartilage of the rib, and then inclining to the middle of the intercostal space, it inosculates with a branch of the mammary, if it belong to one of the spaces of the true ribs;—but if to one of those of the false, then it is ramified in the abdominal muscles, anastomosing with the mammary, epigastric, and circumflex iliac arteries. The last intercostal artery is concealed at its origin by the crus of the diaphragm, to which it gives twigs. It pursues its course along the inferior margin of the rib above, and, at its middle, divides into two branches, one of which passes transversely to the abdominal muscles—the other descends between the oblique muscles to the crest of the ilium, anastomosing with the lumbar arteries, and with the circumflex iliac.

Each I. A. is accompanied in its course by a considerable nerve and one or two veins. These are situated above the artery.

Abdominal Aorta, (Aorta Abdominalis.) The great trunk of the arterial system, seeking the inferior regions of the body, enters the abdomen through the foramen formed by the decussating pillars of the diaphragm, in front and a little on the left of the centre of the spinal column. From this point its course

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SURGICAL OBSERVATIONS.

The *Intercostal Arteries.* It is in part by the free anastomoses which these vessels have with each other over the articulations of the ribs, thus forming a vascular chain on each side of the spine, parallel with the aorta, that the collateral circulation is established in those cases in which the thoracic aorta is obliterated by disease, as has occurred in instances on record.*

The intercostal arteries are concerned in such operations as may be performed on the thoracic walls—also, in wounds of this region. By conveying the instrument, in performing paracentesis of this cavity, near to the margin of the superior rib, the surgeon will easily avoid the trunk of the intercostal, but may wound some of its branches, which are irregular. Mr. Harrison believes that the most troublesome cases of hemorrhage result from using the triangular trochar, which wounds the arteries without dividing them, and does not open the external parts sufficiently to let the blood flow externally, so as to expose the mischief and give access to the vessel. He recommends to first incise the integuments and muscles freely, and then to puncture with a lancet.

When the trunk of the intercostal is wounded, there is often alarming, sometimes fatal, hemorrhage, and especially when the external wound is small or oblique, as when the injury is inflicted by a spicula of a fractured rib, and the hemorrhage is insidious into the cavity of the chest. It is the more obstinate when the artery is but half divided, as is frequently the case because of the vessel being protected on one side by the groove of the rib in which it lies. When the wound does not expose the vessel, we must incise the integuments and muscles along the margin of the rib, always cautiously raising the latter with the director. If we believe the vessel to be but half divided, it should be severed by passing a director under the margin of the rib, and cutting upward and outward on the rib with a narrow bistoury. If it be possible, we should then endeavour to encircle the vessel with a ligature, using a small, abruptly-curved needle. If this does not succeed, we may introduce, within the ribs, a piece of sponge with ligatures attached, and then pull it outward, in such a manner as to make pressure on the vessel. It will rarely be found necessary to practise the expedient of Goulard—that of encircling the rib with a ligature.

* Medico Chir. Trans. vol. v.

is very direct to the fourth—sometimes the fifth lumbar vertebra, where it bifurcates and is resolved into the two common iliacs. When it has fairly entered the abdomen it is nearly in the centre of the spine, but, in its descent, it deviates a little to the left. As the lumbar vertebræ on which it rests are convex anteriorly, the artery is necessarily arched forward, and the most prominent point of the arch is on the third vertebra, nearly opposite to the umbilicus.

The A. A. has, in front, superiorly, the cœliac artery and its branches, the solar plexus of nerves, the lesser omentum, and the stomach. Opposite to the upper edge of the second lumbar vertebra, it has the vena portarum in front, and still anterior to this, the pancreas, which lies transversely upon it. Lower, the duodenum traverses it, behind which the left emulgent vein lies across the artery. Still lower the transverse mesocolon crosses it, and next the oblique root of the mesentery, one of the peritoneal laminæ of which then invests the artery to its termination. In the lower region it has also the convolutions of the small intestines in front of it.

In entering the abdomen, the artery insinuates itself very obliquely between the pillars of the diaphragm, seeming to emerge from beneath the origin of the muscles. The foramen, therefore, is ill-defined, and, as the pillars present tendinous margins toward the artery, there is formed an oblique canal for the transit of the vessel, open below and in front, and bordered by tendon on each side. This structure of the opening prevents the infliction of any constriction upon the artery by the action of the diaghragm. The opening is larger than the artery, and through it are also transmitted the thoracic duct and vena azygos, both on the right of the aorta. The splanchnic nerves are also situated on each side of the aorta as it enters the abdomen.

The vena cava, above the second lumbar vertebra, is separated from the artery by the right pillar of the diaphragm; but below, it lies on the right, and partly in front of the artery.

Branches which arise from the Abdominal Aorta.

The *Diaphragmatic Arteries*, (Arteriæ Phrenicæ.) These are two in number.

1. The *right* ordinarily arises from the aorta, at the point where it emerges from beneath the decussating fasciculi, which cross from one pillar of the diaphragm to the other—before, indeed, the vessel has fairly entered the cavity of the abdomen. Sometimes it arises in common with the *left*, and sometimes it is a branch of the cœliac. It passes upward, and to the right, on the margin of the crus of the diaphragm, giving twigs to it—to the renal capsule, pancreas, and liver. It is then resolved into two branches.

AORTA ABDOMINALIS.

Aorta Abdominalis. Aneurism sometimes occurs in this great vessel, and especially in the vicinity of the cœliac and mesenteric trunks, where, from the manner in which these great branches are implanted upon the artery, the walls of the aorta are less strong than at other points. Aneurism, indeed, is generally more apt to occur at the origin of some great branch than elsewhere. Here there are two of the largest abdominal branches, with merely a narrow bridge of the anterior walls of the aorta between them.

The regular arrangement of the circular fibres of the great vessel is very much interrupted, and they resist with less effect. When, therefore, the walls of the vessel are weakened by organic disease, at this place will aneurismal dilatation, cæteris paribus, most frequently occur. The tumour will then be situated behind the stomach, and, as it increases, will necessarily interfere with the functions of that organ, at first producing, by the mechanical encroachment, the usual symptoms of dyspepsia, but ultimately more complete interruption of its functions.

The disease being so deeply lodged behind the stomach, does not exhibit the ordinary traits of aneurism with much distinctness. Pulsation is felt, but this is diffused, and hence liable to be confounded with the throbbing of the præcordium which sometimes occurs in dyspepsia, and in hysteria. In aneurism, however, the pulsation is firmer, more regular, persistent and synchronous with the pulse; whereas, in other cases, it is irregular and inconstant—is more of a fluttering motion, and is subdued by steady pressure.

The *anterior branch* gives origin, near its commencement, to a twig which inosculates with one from the left phrenic, over the œsophagus. It then follows the line at which the peritoneum is reflected from the diaphragm to the liver, approaches the vena cava, and gives origin to ramuli which pierce the diaphragm and reach the pericardium—others which are lost in the diaphragm or inosculate with those of the opposite side, and some which enter the liver. The branch which may be considered as its continuation, arches on the cordiform tendon, and inosculates with the *left phrenic.*

The *external branch* passes outward, above and behind the liver, and posterior to the cordiform tendon, to terminate by many twigs in the digitations by which the diaphragm arises from the margin of the thorax. It gives a twig to the renal capsule, and anastomoses with the other branch, and with the inferior intercostal and lumbar arteries.

2. The *Left Diaphragmatic* A. arising as the last, ascends along the left crus, giving to it twigs. One branch of larger size it sends to the œsophagus, on which it ascends into the thorax, to inosculate with the œsophageal. It also gives twigs to the renal capsule. On the broad tendon, it is resolved into two branches—the *anterior*, and the *external.*

The *anterior* inclines from behind forward—reaches the anterior expansion of the muscle, and anastomoses with the opposite artery over the œsophagus. It is then resolved into numerous branches, one of which anastomoses behind the cordiform tendon with its fellow of the other side.

The *external ramus* is larger. It passes directly outward behind the left lobe of the cordiform tendon—ramifies in the muscle, inosculates with the other branch, and with the intercostal and lumbar arteries. It even sends twigs to the spleen.

The Cœliac Artery, (Arteria Cœliaca.) This is the first considerable branch of A. A. appropriated to the viscera of the abdomen, after the trunk has fairly entered that cavity. It is at once the shortest, and, in diameter, the largest branch of this region. It arises at right angles from its parent trunk, opposite to the

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SURGICAL OBSERVATIONS.

In the lower portions of the tract of the A. the tumour can be more nearly approached, and more distinctly felt. The bowels should first have been emptied by a cathartic, and the examination should be made, while the belly is lank, by placing the patient on his back, with his chest and hips raised—the abdominal muscles being thus relaxed. With the fingers of opposite hands the anterior walls may be pressed inwards upon the sides of the spine, and thus the aorta be grasped. In the case of a medical pupil of the University of Maryland, in 1828, who had dilatation of the aorta, I could thus trace this trunk from its entrance to its bifurcation. As other tumours, those of the mesenteric glands, &c. may borrow a pulsation from the artery, they should be carefully pressed away from it.

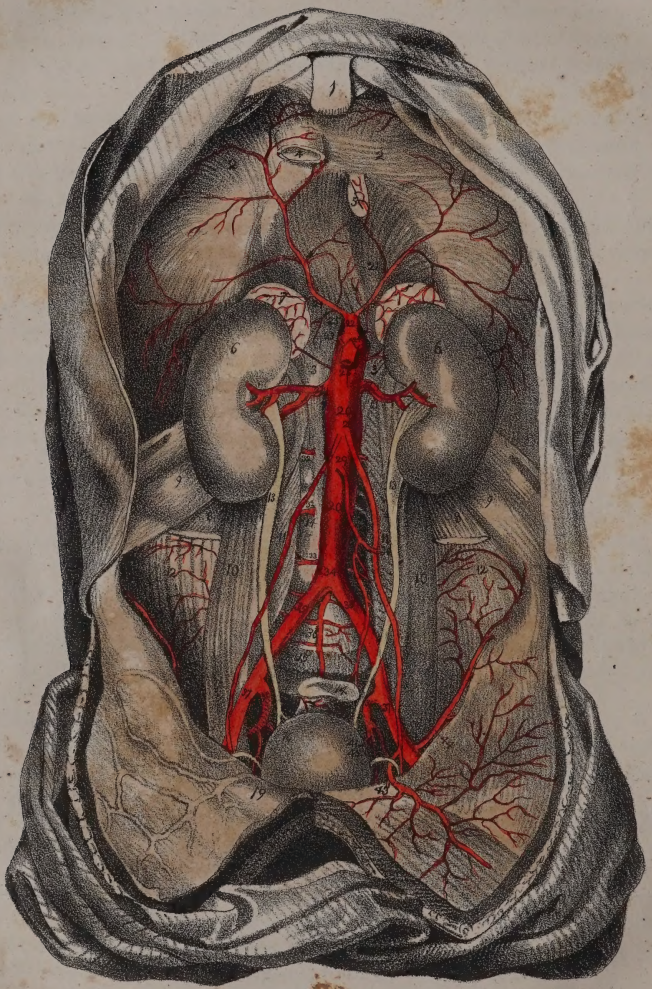
Aneurism of this region may burst into the duodenum, into the stomach, into the cavity of the belly, or beneath the peritoneum. When the disease is urged backward and outward on the psoæ muscles, it may cause caries of the vertebræ, and by pressure on the lumbar nerves, pain in the loins, and partial paralysis of the lower extremities. Sometimes the disease produces all the symptoms of lumbar abscess.

If it be ever desirable to make pressure upon the aorta for the purpose of checking the gush of blood from one of its wounded branches, the force should be applied just on the left of the umbilicus, where the convexity of the spine is most prominent.

A case may be imagined in which it would be justifiable, as in the case of Mr. A. Cooper, to parry an otherwise immediately fatal hemorrhage, and thus protract life, by casting a ligature even around the aorta. This is accomplished by making an incision along the linea alba—throwing the viscera to the left side—lacerating the peritoneum, and encircling the vessel with Bellocque's or Weiss' instrument conveying an animal ligature.

A wound of the aorta, or one of its great branches, is usually even more quickly fatal than a wound of the heart; because, in the former case, the stream of blood rushes directly upon the wound; whereas, in the latter, the wound is not so directly opposed to the current of blood, and is also partially closed at each systole of the organ. The wound is also through thicker walls, and may be oblique. The effusion, moreover, is in some degree restrained by the pericardium.

Pl. 10.



Drawn on Stone by S. Smith

G. Willig's Lith.

junction of the last dorsal with the first lumbar vertebra. It inclines to the right, between the laminæ of the lesser omentum which are reflected upon the posterior walls of the abdomen. In front and above it, is the left lobe of the liver. Below, it rests on the border of the pancreas. On either side are situated the semilunar ganglia of the sympathetic nerve, and around it is formed the solar plexus. The stomach is in front, more superficially than the pancreas. The cardia is on the left—the pylorus, more remotely, on the right.

The trunk of the C. is but half an inch in length, and at its extremity it is abruptly resolved into three branches: 1, the coronary of the stomach; 2, the hepatic; 3, the splenic.

1. The *Coronary of the Stomach*, (Coronaria Ventriculi,) the smallest of the three branches, abruptly ascends, inclining to the left and a little forward. On reaching the cardia, it curves downward on its right—thus gaining the lesser curve of the stomach, which it follows, between the laminæ of the lesser omentum, to the pylorus, where it inosculates with the pyloric.

Where it bends downward, near the cardia, it sends obliquely upward and outward, branches to the œsophagus, (*œsophageal.*) They vary in number; some of them ascend upon the œsophagus—others surround the cardia transversely, sending branches to the large extremity of the stomach, and inosculate with the vasa brevia.

As the C. A. traverses the lesser curvature of the stomach, it constantly imparts to that organ twigs which are variable in number and size. These are soon resolved into a beautiful tissue of serpentine ramuli, which anastomose with each other—penetrate the muscular and mucous membranes of the stomach, and meet the twigs of the gastro-epiploic arteries. Sometimes the coronary sends a branch to the liver—sometimes to the diaphragm.

2. The *Hepatic Artery*, (Arteria Hepatica,) is twice as large as the C. From its origin, it is prolonged to the right and a little forwards, passing beneath the small lobe of the liver, and approaching the pylorus. Thence it bends upward, toward the great fissure of the liver. In this section of its course, it gives origin to the *pyloric* and the *right-gastro-epiploic* arteries.

The *Pyloric A.* springs from the H. on the right side of the pylorus. Thence it passes to the left, along the small curvature of the stomach, and between the laminæ of the omentum minus, to inosculate with the coronary. It supplies a portion of the stomach, in the same manner as the coronary—gives twigs to the pylorus, and some to anastomose with the following branch. Often the P. is a branch of the following;—frequently it arises beyond it.

The *Right Gastro-epiploic* A. also arises on the right of the pylorus—somewhat behind it, and from the lowest sinuosity of the hepatic. It dips behind the pylorus—descending directly to the great curvature of the stomach, passing over the pancreas. Thence it is inflected to the left, along the great curvature of the stomach, between the laminæ of the great omentum, to inosculate with the gastro-epiploica sinistra, beyond the middle of the arch.

Where it descends, this branch gives small twigs to the duodenum, and from it there springs one slender vessel, which crosses the posterior face of the pancreas, and inosculates with the pancreatic and splenic branches. Where it skirts the great curvature of the stomach, the G. furnishes a multitude of tortuous

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INDEX TO PLATE X.—No. 1 marks the Ensiform Cartilage of the Sternum; 2, 2, the Cordiform Tendon of the Diaphragm; 3, 3, Crura of the D.; 4, Vena Cava; 5, Œsophagus; 6, Kidneys; 7, Renal Capsules; 8, 8, Quadrati humborum muscles; 9, Abdominal m.; 10, 11, Psoæ m.; 12, 12, Iliaci Interni; 13, 13, Ureters; 14, Vertebræ; 15, junction of Vertebra and Sacrum; 16, Bladder; 17, Rectum; 18, 18, Vasa Deferentia; 19, walls of the Abdomen; 20, Aorta Abdominalis; 21, 21, Phrenic Arteries; 22, Cœliac; 23, Hepatic; 24, Splenic; 25, Coronary; 26, Sup. Mesenteric; 27, 27, Renal; 28, Spermatic; 29, Inferior Mesenteric; 30, Colic branch of I. M.; 31, Hemorrhoidal branch; 32, 33, Lumbar; 34, bifurcation of Aorta; 35, 35, Primitive Iliacs; 36, Sacra Media; 37, 37, External Iliacs; 38, Internal Iliacs; 39, Ischiatic; 40, Obturator; 41, Middle Hemorrhoidal; 42, Epigastric; 43, Spermatic branch of E.; 44, Circumflex Iliac.

twigs to the membranes of that organ; they anastomose collaterally, and meet the branches of the coronary and pyloric. Inferiorly, this arterial arch sends twigs from its convex side to the great omentum—some of which are reflected between the posterior laminæ of that duplicature where they pass backward to embrace the colon, and inosculate with the vessels of the intestine.

The branch which the stomach thus borrows from the liver is of considerable size.

The Hepatic A. now directly ascends to the great cleft of the liver. It is here nearly parallel with the vena portæ in front of it; it is on the left of the ductus communis of the liver, and behind its plane. As it approaches the great fissure, toward the right portion of the lesser lobe of the liver, it is resolved into two branches—the *right* and *left*.

The *right branch* passes upward and outward, crossing beneath the hepatic duct. Beyond this it gives origin to the *cystic artery*, which attaches itself to the neck of the vesicula, and traverses it longitudinally, diffusing its ramuli between its membranes, and sending between the cyst and liver a branch which is common to both organs. The *right* branch of the H. then enters the great, or transverse fissure of the liver, and ramifies in the right lobe.

The *left branch* ascends obliquely inward—enters the transverse fissure, and ramifies indefinitely in the left lobe and the lobulus spigelii. The branches of both accompany the ramifications of the vena portæ.

3. The *Splenic Artery*, (Arteria Splenica,) is obviously larger than the hepatic. From its point of origin, it passes horizontally from right to left, meandering slightly, and bending backward behind the large extremity of the stomach. In this course it rests in a groove formed in the superior margin of the pancreas. At length it reaches the fissure of the spleen, and is there resolved into its terminal branches.

In its progress from its point of origin to that of its destination, it gives rise, first to the,

Pancreatic branches, small and numerous twigs which descend to the pancreas, ramify among its glandulæ, and, in its substance, inosculate with twigs from the right gastro-epiploic.

Left Gastro-epiploic. This is commonly one of the terminal branches of the splenic. It is usually smaller than the g. dextra, but sometimes is larger, and then appears as the continued trunk of the splenic. At first it passes upward and outward, behind the great extremity of the stomach—then descends on the great curvature. At its origin, it imparts twigs to the pancreas. On the great curvature, in the root of the omentum, it is distributed in a manner precisely corresponding to that of the right gastro-epiploic, with which it is continuous.

The S. is resolved into its terminal branches (two or three in number) at some distance from the fissure of the spleen. These are subdivided into seven or eight, which, diverging at acute angles, form a fan-like expansion in a duplicature of the peritoneum, and enter the fissure of the spleen at as many distinct apertures. They then subdivide and anastomose indefinitely, seeming to form the mass of the organ.

The *Vasa Brevia* are short but considerable twigs which pass off from the terminal branches of the S. near the spleen. They are appropriated to the large extremity on the stomach, near the cardia, expanding over the anterior and posterior surfaces, and anastomosing with branches of the coronary, around the cardiac orifice.

It will be observed that, although the coronary A. of the stomach is much the smallest of the branches of the cœliac, yet, as the stomach borrows the large right gastro-epiploic from the hepatic—the vasa brevia, and the left gastro-epiploic, from the splenic, it receives a not less copious supply of arterial blood than the liver or spleen.

The Superior Mesenteric Artery, (Arteria Mesenterica Superior.) This great vessel is often equal in magnitude to the cœliac. It is the proper vessel of the small, and a considerable portion of the large, intestines. It takes its oblique origin from the aorta, a little on the right of its centre in front, about half an inch from the origin of the cœliac. Its general direction being downward and forward, it bends, near its origin, a little to the left. It passes behind the pancreas and over the inferior duplicature of the duodenum; thus it insinuates itself beneath the peritoneal laminæ which form the mesocolon and embrace those viscera.

Then the M. A. insinuates itself between the laminæ of the mesentery, which are produced downward and to the right from the inferior laminæ of the mesocolon. The artery seems to carry downward this duplicature of the peritoneum, and thus to form for itself the mesentery. In its descent the M. A. bends to the right, thus forming an arch of very wide span, the convexity of which is to the left and forward, presenting towards the track of the small intestines, and approaching them more and more nearly as it descends. Near the extremity of the ileum, the slender continuation of the M. A. inosculates with the right inferior colic.

In the course above described, the M. A. at its origin, is buried beneath the pancreas—a little lower, it has the duodenum behind it, and the colon in front—still lower, its arch is enveloped in the doublings of the small intestines.

Near its origin, it gives off duodenal and pancreatic twigs which inosculate with the splenic and hepatic arteries. From its great arch, where, enveloped in the mesentery, it gives origin to two ranks of numerous and important arteries:—1, those which spring from the concavity, on the right; 2, those from the convexity, on the left.

The *Superior Right Colic Artery*, is the first of the former rank. It takes its origin where the M. is passing from the mesocolon into the mesentery. It directs itself horizontally forward in the mesocolon, and, near the middle of the colon, is resolved into two branches which diverge abruptly. Of these, the *right* is appropriated to the right of the colic arch, and inosculates with the *right middle colic*. The *left* passes to the left portion of the arch, and inosculates with the colica sinistra of the *inferior mesenteric*.

The *Middle Right Colic*, when not a branch of the last, arises an inch or two below—passes obliquely upward and outward, beneath the doubling of the peritoneum which is between the mesentery and mesocolon—reaches the upper part of the ascending colon, and abruptly divides into two branches, one of which follows the colon to its head, inosculating with the right inferior C. while the other ascends and anastomoses with the last described.

The *Inferior Right Colic*, arises near the last—enters the right mesocolon in the same manner, but transversely. It then dips towards the cæcum, and is resolved into three branches. The first of these bends upward along the colon, and meets the last described. The second descends and forms an arch with the mesenteric continued. The third, arising from the angle of the others, passes behind the colon and cæcum. It there sends a twig to the vermiform appendix, and is then resolved into two rami—one to the cæcum—the other to the colon.

By their free anastomoses, the above branches form an arch of very wide span, corresponding to the form of the arch of the colon. From the convexity of this arch, which is near the colon, a multitude of twigs pass between the laminæ of the mesocolon to the intestine. They insinuate themselves beneath the serous coat, and ramify indefinitely in the other tunics.

Branches from the *Convexity* of the *S. M.* These vary in number from fifteen to twenty. They pass downward and to the left, involved in the mesentery, and are appropriated to the lower portion of the duodenum and the whole track of the small intestines. Near their origins, they lie closely upon each other. After a short course they are resolved into branches which anastomose collaterally, and form primary arches from which other branches arise, which divide—anastomose in the same manner, and form secondary arches. From these arise smaller twigs that form a third class of arches;—from these is produced a fourth;—and from branches of the fourth, a fifth is formed. From the convexities of the last, near the intestine, arise the ultimate branches which pass to the intestinal tunics.

From this division, subdivision, and free anastomoses, there results a beautiful arterial net-work, the meshes of which are variable in size and form. They give twigs to the mesentery and glands. The ramuli which pass to the intestines ramify on both sides, beneath the peritoneal coat, to extreme minuteness. They inosculate around these organs, and every where send through the muscular and cellular tunics, filaments which form an exceedingly delicate and close tissue in the mucous membrane, and especially its papillæ.

The Capsular Arteries, (Arteriæ Capsulares,) are two in number and small, appropriated to the renal capsules. They arise laterally from the aorta, a short distance above the emulgent arteries, and nearly opposite the superior mesenteric. Sometimes they are branches of the cœliac. They wind backward and outward, over the sides of the spine, and are resolved into three or four branches which sub-divide and pierce the surface of the renal appendages. Sometimes the trunk sends a twig to the diaphragm—sometimes to the kidney.

The Renal, or Emulgent Arteries, (Arteriæ Renales.) These great arteries of the kidneys, one on each side, spring, at right angles, from the sides of the aorta, a little below the origin of the s. mesenteric. The left is commonly higher and more prominent than the right. They wind round the sides of the spinal column, being buried in abundant adipose substance, and covered anteriorly by the renal veins—the right passing also behind the vena cava. They approach the fissure of the kidney, and are resolved, at acute angles, into three or four branches. Before they reach the kidney, they give twigs to the surrounding adeps, and to the renal capsules; sometimes they furnish the spermatic arteries.

The terminal branches of the trunk insinuate themselves into the fissure of the kidney between the pelvis of the organ, which is situated behind and below, and the ramifications of the renal veins, which are above and in front. The are then resolved into twigs, which pass between the gland and the pelvis, and ramify around the infundibula. They anastomose around the papillæ of the kidney, and send innumerable twigs into the cortical substance of the organ. Sometimes there is more than one renal artery. I have seen one arising in association with the lumbar, having this destination.

The Spermatic Arteries, (Arteriæ Spermaticæ,) two in number, arise, one on each side, from the aorta, on the antero-lateral aspects. Sometimes they arise from the emulgent. As they descend obliquely downward and a little outward, they form very acute angles with the aorta. Soon joining the spermatic veins, they pass down behind the peritoneum, resting behind, first on the spine, then on the psoæ muscles, crossing the ureters at very acute angles. They cross the common iliac arteries near the margin of the pelvis, and pass before the external iliacs to the internal abdominal rings. The right spermatic passes before the vena cava. Their course is exceedingly tortuous; they being often contorted upon themselves.

In the male, the S. A. having given a few twigs to the cellular tissue and glands, enters the inguinal canal, gives twigs to the spermatic cord, and descends to the testicle. As it approaches that organ, it is resolved into two fasciculi of twigs—one to the testis—the other to the epididymus. The first pierce the upper margin of the testis, giving many ramuli to the albuginea, which conveys them into the body of the testis, and distributes them upon the fibrous septa which form the cells containing the convoluted seminal ducts. Those of the second fasciculi penetrate the globus major of the epididymis—expand in that body—give twigs to the albuginea, and to the body of the testis.

In the female, the S. A. has a very different destination. After crossing the psoas muscle, it plunges into the pelvis, and passes to the ovary. Most of its ramuli are lost in this body, but some of them are prolonged upon the tube of Fallopius, to the uterus, where they anastomose with the uterine arteries.

No branches issue from the right side of the arch of this vessel; but on the left arise three, termed the left colic arteries.

Index to Plate XI.—Figure 1 marks the Right lobe of the Liver; 2, the Left; 3, Lobulus Quartus; 4, Lobulus Spigelii; 5, Umbilical Fissure; 6, Gall Bladder; 7, 7, Vena Portarum; 8, Cystic Duct; 9, Hepatic D.; 10, Duc. Communis; 11, 12, Cura of the Diaphragm; 13, Œsophagus; 14, 14, Stomach; 15, Cardia; 16, Duodenum; 17, Pancreas; 18, 18, Omentum; 19, Rib; 20, Abdominal Walls reflected; 21, Aorta; 22, Phrenic Artery; 23, Cœliac; 24, Hepatic A., 25, Coronary; 26, Splenic; 27, Cardiac and Œsophageal branches; 28, proper Coronary; 29, Right Coronary; 30, Right Gastro-epiploic; 31, Duodenalis; 32, 32, R. Gastro-epiploic continued; 33, Left G. epiploic; 34, Right Hepatic; 35, Left H.; 36, 37, Cystic Artery; 38, an occasional ramus to left lobe.

Drawn on Stone by S. Smith.

C. Whitney's Lith.

The Inferior Mesenteric Artery. (Mesenterica Inferior.) The second great artery of the intestines is smaller than the superior. It takes its origin low on the anterior part of the aorta, about an inch and a half from its termination. It descends, slightly inclining outward, beneath the left root of the mesentery. It then is inflected to the right and forward, and enters the left portion of the mesocolon, forming a curve, the convexity of which looks to the left. On reaching the brim of the pelvis, it plunges into that cavity, embraced by the laminæ of the meso-rectum, and terminates near the anus.

The *Superior Left Colic* is the largest of the three. It arises opposite the extremity of the aorta—passes transversely to the left—approaches the colon of that region, and divides into two branches. One of these is inflected upwards, along the arch of the colon, and anastomoses with the superior right colic. The other descends in the mesocolon and anastomoses with the middle left colic.

The *Middle Left Colic*—sometimes a branch of the last—sometimes wanting, passes to the superior part of the sigmoid flexure of the colon. It divides into two branches—one, the superior, which inosculates with the last described—the other, the inferior, with one of the branches of the inferior colic.

The *Inferior Left Colic* directs itself towards the middle of the sigmoid flexure of the colon, and is resolved into two branches. The superior forms an arch with the preceding—the lower descends into the pelvis and inosculates with the I. M. continued.

The inferior mesenteric continued gives off a few irregular branches, and is then resolved into two rami, which descend behind the rectum, and are denominated *superior hemorrhoidal arteries.* These vessels, as they descend, plunge among the longitudinal muscular fibres of the rectum, ramifying, as they descend, to extreme minuteness, and furnishing lateral twigs which embrace the rectum and anastomose around it. Others anastomose with the middle and inferior hemorrhoidal arteries—some with the lateral sacral arteries.

The Lumbar Arteries. These are commonly four in number, on each side—sometimes five—sometimes only three. They arise from the latero-posterior aspects of the aorta, and pass transversely outward, over the middle of the bodies of the vertebræ, covered by the psoas muscles, or by the crura of the diaphragm. On reaching the roots of the transverse processes of the lumbar vertebræ, after giving a few twigs to neighbouring parts, they are resolved each into two branches, a *dorsal* and a *lumbar* branch.

The *Dorsal Branches* are small;—they send twigs into the spinal canal, to the spinal marrow and its membranes, and then enter the mass of muscular fasciculi which arise from the sacrum and spine, where they inosculate with each other.

Of the lumbar branches—that of the first trunk passes outward along the inferior border of the last rib, tracing the origin of the diaphragm. It is inflected downward, and then forward, between the peritoneum and the transverse muscle of the abdomen in which it ramifies. That of the second L. A. is small—

SPERMATIC ARTERY.

The *Spermatic Artery* sometimes bears an interesting relation to the sac in inguinal hernia. Sometimes the entire cord, which is usually behind the tumour, is thrust in front of it. In other instances of chronic rupture, the sac insinuates itself between the constituent vessels of the cord, placing usually the vas deferens behind, and the artery in front. In both cases the artery is exposed to the knife in making the usual incisions. If, however, the operator proceed with caution, it can easily be discerned and avoided.

In the extirpation of the testis, it has occasionally been found difficult effectually to secure the spermatic artery, in consequence of its recoiling so promptly after division into the loose sheath of the cord, within which it is drawn by the cremaster muscle. Some have advised to apply a skein of thread as a temporary ligature to the cord, before its division, in order to draw it down when such retraction occurs, and apply ligatures to the individual vessels, when the cord is divided. The temporary ligature is then to be removed. This expedient is tedious and painful, but is not so much to be deprecated as the cruel practice of including the entire cord—nerves, arteries, veins, and vas deferens, practised by some. I have witnessed the agony of pain which this produces.

descends into the substance of the quadratus muscle, and ramifies in its substance. The *lumbar branch* of the third artery is large;—it insinuates itself between the quadratus lumborum and transverse abdominal muscles, approaches the crest of the ilium, and divides, behind its middle, into two branches. These perforate the broad muscles of the abdomen, near their origins, and are distributed to their fasciculi, sending some of their branches down to the glutei muscles, where they inosculate with the gluteal artery. The *anterior branch* of the fourth lumbar, still larger, passes transversely between the psoas magnus and quadratus lumborum, along the origin of the latter. It gives twigs to this muscle—passes over the margin of the ilium, and gives its terminal branches to the glutei muscles.

SECTION IV.

ARTERIES OF THE PELVIS AND INFERIOR EXTREMITY.

Opposite the lower part of the fourth lumbar vertebra, the abdominal aorta is resolved into its two great branches, the primitive iliacs. From the angle of bifurcation, however, there is usually continued directly from the aorta the middle sacral artery. As this vessel sometimes springs from the root of one of the iliacs, and as it is appropriated to the pelvis, I shall here describe it.

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The method which I have found to be preferable to any other, is to expose the cord fairly—to feel for the arteries, of which it may be necessary to tie more than one—then to divide the loose tissue of the cord, parallel to the vessels, and, with an armed needle, to secure them separately before the cord is divided.

Common Iliac Artery. A few years since, the surgery of this vessel would have been given in few words. The feasibility of obliterating it with the ligature was then not even discussed. Perhaps such a proposition, thirty years ago, would have been received with the same kind of surprise with which we read the observations of a recent French writer, who gravely gives us the reasons why he believes that the amputation of the head will never be successfully accomplished. Here, again, we claim for American surgery the honour of one of the boldest achievements which science and art have ever accomplished. The complete success of Professor Mott's ligature of the common iliac artery entirely eclipses all former operations upon the great vessels. He has left nothing to be achieved in this department of surgery more worthy of admiration. He has cast "a rood beyond the farthest mark." It may well, as he remarks, console him for the unexpected failure of his operation on the A. innominata.

For the particulars of the case above alluded to, I must refer to the American edition of Cooper's Surgical Dictionary. The disease requiring this dernier expedient was a large aneurism of the external iliac artery, which was affected even to the origin of the internal iliac. The operator commenced his incision just above the external abdominal ring and carried it obliquely upward and outward, curving slightly, to a little beyond the anterior spinous process of the os ilium—about five inches in length. This he was obliged subsequently, in consequence of the magnitude of the tumour, to enlarge upward, half an inch within the ilium, to the extent of three inches. The broad tendon of the external oblique was first exposed;—the division of this brought into view the fibres of the internal oblique. These were cautiously divided near their origin from Poupart's ligament, with the aid of the forceps, and the spermatic cord was brought into view. The tissue enveloping this being divided, the finger was guided by the cord through the internal ring, and then the internal oblique and transversalis muscles were divided with facility to the extent of the incision. In effecting this, the circumflex iliac artery was divided. The operator then endeavoured to denude the tumour of its peritoneal covering, by pressing it upward; but its strong adhesions rendered this extremely difficult. The intestines were also pressed downward very forcibly by the violent action of the abdominal muscles, rendering it particularly difficult to approach the common iliac. This, however, was in part overcome by the use of curved spatulæ, and a flat, thin piece of wood. Still it was extremely difficult to obtain a view of the artery, and the operator was compelled to be governed

Middle Sacral Artery, (Arteria Sacra Media.) This little azygous vessel, from its point of origin descends directly along the vertical diameter of the sacrum, being the proper artery of that bone and its membrane. When it arises from the iliac or one of its branches, as it sometimes does, it often has a fellow on the other side. The artery terminates at the summit of the coccyx, anastomosing there with the lateral sacral artery. As it descends, it gives origin to two orders of twigs; 1, the *posterior* or *external;* 2, the *internal.*

1. The *Posterior Branches*, usually four in number, insinuate themselves into the anterior foramina of the sacrum and reach the sacral canal. There they are each resolved into two twigs, one of which traverses the anterior walls of the canal, nourishing its lining membrane and the ganglia of the sacral nerves. The other emerges from the posterior spinal hole, and is appropriated to the muscles which are situated on the dorsum of the bone.

2. The *Internal Twigs* are very irregularly distributed to the periosteum, the sacral nerves, the pyriform muscles, &c. They inosculate freely with the branches of the lateral sacral, on the surface of the bone.

When the middle sacral exists on each side, it sometimes, as it descends, plunges entire into the third sacral hole.

The Primitive Iliac Artery, (Arteria Iliaca Communis.) The primitive iliacs diverge from each other at an angle somewhat acute. Each vessel descends, curving a little forward, obliquely along the brim of the pelvis, to the sacro-iliac symphisis, where it is resolved into the external iliac and the hypogastric, or internal iliac. In the female, the angle formed by the common iliacs is, for obvious reasons, larger than in the male.

The right C. A. is larger than the left, its origin being on the left of the centre of the spine. It descends more obliquely outward. At its origin, it rests on the inferior extremity of the vena cava, and it crosses

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chiefly by the touch. At length he succeeded in denuding the common iliac to midway between its origin and termination. A ligature was then cast around it, and before securing it, the operator, with much difficulty, obtained a distinct view of the vessel. The ligature being drawn, the pulsation in the aneurism instantly ceased. The wound was then closed with sutures passed through the walls of the abdomen, assisted by adhesive strips.

In a little more than two months the aneurism had totally disappeared, and there remained none of the effects of the disease, except a slight lameness.

In this operation, the principal difficulty encountered seems to have arisen from the forcible protrusion of the intestines at the extensive opening necessarily made in the walls of the abdomen. This tendency to protrusion would of course be much increased by the very efforts which were made to dilate the wound, since any traction exercised upon the walls of the abdomen would provoke the muscles to spasmodic contraction. The operator was also seriously incommoded by the aneurismal tumour, which concealed the trunk of the artery in the direction in which he sought it. Both of these sources of embarrassment must occur, in a greater or less degree, in all cases in which the operation is performed in this method. For these reasons, and others derived from operating on the dead subject, I am disposed to prefer the method suggested by Mr. Harrison, as that by which this operation may be accomplished with the greatest facility and safety. He advises the same incision, both for the common iliac and the hypogastric.

"Place the patient on his back and bend the lower extremities on the trunk to relax the abdominal muscles. An incision three or four inches long is to be made through the integuments of the lower part of the abdomen, parallel to the epigastric artery, that is, in a line drawn from the centre of Poupart's ligament towards the umbilicus. The inferior extremity of this incision may terminate about an inch above Poupart's ligament, so as not to endanger the spermatic cord, and the superior extremity may end at the outer edge of the rectus muscle. The three laminæ of the abdominal muscles are next to be cautiously divided on a director to the same extent; the fascia transversalis may then be torn through with the finger, and the peritoneum can easily be detached from the iliac fossa towards the pelvis. This part of the operation will be facilitated if the patient's bowels have been previously emptied by a smart cathartic. If the finger be now passed to the inner side of the cavity which has been thus formed, the pulsation of the external iliac

obliquely the right great branch of that vessel. The left C. A. has the corresponding left vein (left iliac vein) within and behind it, nearly parallel. Posteriorly, both arteries rest first upon the spine, and then upon the psoæ muscles. Anteriorly, they are each crossed nearly at right angles by the ureters. The peritoneum also closely invests them. The right C. I. has, more remotely in front of it and above, the left side of the cæcum and the vermiform appendix. The left branch has the beginning of the rectum before it.

With the exception of a few nameless and irregular twigs to the ureters, peritoneum, &c. these trunks give origin to no branches.

1. The Internal Iliac, or Hypogastric Artery, (Arteria Iliaca Interna.) This great vessel is the proper artery of the pelvis and its contained viscera. It is something smaller than the external iliac, from which it abruptly diverges and plunges almost directly downward, along the sacro-iliac symphisis, into the cavity of the pelvis. As it descends, it bends slightly forward. At its termination it is resolved, in a very inconstant manner, into several considerable branches. The first of these is the:—

1. *Ilio-Lumbar*, (Arteria Ilio-Lumbalis.) This vessel is very variable in regard to its place of origin;—sometimes springing from the trunk, near its middle; sometimes from the glutæal. It winds outward, backward, and upward, before the lumbo-sacral nerve and behind the psoas muscle, to which it imparts branches. Near the margin of the sacrum, it is resolved into two branches—the *ascending* and the *transverse*.

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artery will be felt, and by following this to its origin, or towards the spine, the internal iliac will be discovered lying internally and rather posteriorly to it." To reach the common iliac, it will then only be necessary to urge the finger a little further in the same direction, carefully lifting the peritoneum and the ureter from the artery. The sides of the wound should be retracted with the means used by Professor Mott. The aneurism needle, it appears to me, can be passed with most facility by insinuating its point under the artery from without, inward. There would thus be less danger of wounding the vein on which the artery lies, and the instrument would thus be used with more freedom.

The ligature of the common iliac artery has recently been performed by Dr. Bushe, a distinguished surgeon of New York, on a female infant not two months old, for the cure of a congenital aneurism seated in the labium. The child survived the operation, but perished a few weeks after, from a disease of the knee joint.

In a case of hemorrhage from gun-shot wound, Professor Gibson, of the University of Pennsylvania, had occasion to cast a ligature around this vessel. The patient lived fifteen days after the operation, and then perished from peritoneal inflammation and from ulceration of the artery. The occasional feasibility of securing this vessel, therefore, can no longer be questioned; but the humane surgeon will attempt it only when urged by imperative necessity.

Internal Iliac or Hypogastric. It will be borne in mind that this artery, near its origin, rests upon the internal iliac vein, that the communicating lumbar nerve passes down on the outside of it, and that the ureter, loosely involved in the peritoneum, passes in front of it.

That certain diseases or injuries of the glutæal or ischiatic artery may render it desirable to secure the internal iliac, and that the tying of this artery is practicable with a reasonable probability of success, has been established by obser-

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Index to Plate XII.—1, Lumbar Vertebræ; 2, Sacrum; 3, section of the Symphysis Pubis; 4, Penis; 5, Scrotum; 6, section of Integuments; 7, do.; 8, section of the Rectus m.; 9, internal face of Rectus; 10, Transversalis m.; 11, internal Oblique m.; 12, Psoas magnus, and near it the Psoas parvus; 13, insertion of the Psoas parvus into the linea ileo-pectinea; 14, 14, Levator Ani m.; 15, Cauda Equina; 16, origins of the sacral nerves; 17, Interspinal muscles; 18, Rectum; 19, Bladder; 20, 20, Spermatic Cord and Vesicular Seminalis; 21, 21, Sacral Nerves; 22, Obturator Nerve; 23, Aorta; 24, Inferior Mesenteric Artery; 25, 25, Common Iliacs; 26, External Iliac; 27, Internal Iliac; 28, Glutæal; 29, Ischiatic; 30, origin of Ilio-Lumbalis; 31, Obturator; 32, lateral Sacral; 33, Cystic Artery; 34, branch of same to the Vesicula Seminalis; 35, Umbilical a.; 36, Ilio-Lumbalis; 37, Glutæal insinuating itself behind the pyriform muscle, and turning round the margin of the ischiatic notch; 38, Ischiatic, passing below the pyriform muscle; 39, Internal Pudic a.; 40, do.; 41, Middle Hæmorrhoidal; 42, Epigastric; 43, Internal Circumflex Iliac; 44, Sacra Media.

Drawn on Stone by S. Smith

G. Willig's Lith

The *Ascending branch* passes vertically upward, between the psoas muscle, os ilium and fifth vertebra, anastomosing with the last lumbar artery. In its course it furnishes twigs to the psoas, iliac, and quadratus lumborum muscles; also to the sacrum and os ilium.

The *Transverse branch* passes almost directly outward, between the psoas and iliacus muscles, and is soon resolved into terminal branches. Some of these are spread superficially upon the iliacus muscle, anastomosing with the circumflex iliac.

The deeper twigs perforate the muscle, and reach the periosteum of the bone in which it is lodged. One of them pierces the bone by a nutrient foramen in its fossa.

2. The *Lateral Sacral Arteries*, (Art. Sacræ Laterales.) Usually there are two of these on each side,—sometimes there is but one. They occasionally arise from the glutæal. They descend, bending inward and forward, in front of the anterior formina of the sacrum. At the summit of the coccyx, the lower one anastomoses by an arch with the middle sacral artery. As they traverse the sacral holes, they give off *posterior* twigs, which enter them and reach the cauda equina. These are generally four in number. On entering the canal, each one is usually resolved into two branches—an anterior, which is appropriated to the anterior walls of the canal and to the ganglia of the sacral nerves—a posterior, which emerges from the posterior sacral hole, and supplies the muscles on the dorsum of the sacrum. Internal twigs, also, arise from this artery, sending their branches inward along the concavity of the sacrum to supply the nerves, pyramidal muscles, and bone.

3. The GLUTÆAL ARTERY, (Arteria Glutæa.) This is the largest branch of the hypogastric trunk. Descending, it winds downward, outward, and backward, and emerges from the cavity of the pelvis, at the deepest part of the sciatic notch, above the pyramidal muscle. It then gets beneath the great glutæus muscle—approaches the posterior edge of the glutæus minimus, and is there resolved into two branches, a *profound* and a *superficial*.

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vation and experiment. The operation has been but four times attempted, and in three of these instances it was successful.

Mr. Stevens, an English surgeon residing in Santa Cruz, first successfully executed the very difficult and formidable operation of tying the internal iliac. The case is related at length in vol. 5th of the Medico-Chirurgical Transactions, p. 422. In this instance the operator made his external incision parallel with the epigastric artery, and about half an inch upon the outside of it, to the extent of five inches. The muscular walls being divided, the peritoneum was raised without difficulty from the internal iliac and psoas muscles and thrown inward in a direction from the anterior superior spinous process of the os ilium, toward the origin of the internal iliac artery. The vessel was thus found without difficulty.

The internal iliac is sometimes the seat of aneurismal dilatation. It will probably not be easy, in every case, to distinguish such disease from a similar tumour of the external iliac. That of the former, however, will be less distinctly felt, and will seem to rise from the cavity of the pelvis. It will interfere more with the functions of the bladder, rectum and uterus, and, by direct pressure on the sacral plexus, will cause pains to shoot down the course of the sciatic nerve, along the posterior part of the thigh and leg. The muscles of these regions may become, in some degree, paralyzed. In aneurism of the external iliac, the tumour will, to the touch, be more prominent and circumscribed; it will cause œdema of the limb by pressure on the iliac veins and on the absorbent trunks;—also, pain or paralysis of the anterior muscles of the thigh. The pulse of the arteries of the leg and thigh will be less vigorous than in the opposite side, and will be aneurismal.

Glutæal Artery. This great vessel is more exposed to injury than would at first be supposed. It lies, it is true, deeply buried beneath the most voluminous muscle of the human body; but it is situated in a region on which unseen blows and wounds are inflicted;—one, also, which may suffer contusions in falling, the artery being injured by the sharp margin of the bone around which it turns.

This artery has, in several instances, been the seat of traumatic aneurism, requiring the difficult operation of cutting for its trunk where it emerges from the pelvis. The formidable case of Mr. John Bell, will at once occur to the reader.

The *Profound* branch directs itself upward and forward, between the medius and the minimus muscles. It gives a twig to the bone, and is then resolved into three or four branches. One of these skirts the convex margin of the glutæus minimus, and forms an arch, corresponding to the spine of the ilium. This gives numerous branches from its convexity to the glutæus medius, and from its concavity to the minimus. Another twig is sent transversely across the glutæus minimus, giving twigs to it, and then plunging into the glutæus medius. A third twig of the deep branch, after giving ramuli to the pyramidal and g. minimus muscles, crosses the fibres of the latter—passes along the iliac bone, gets beneath the tensor vaginæ, and is then appropriated to the capsule of the hip joint, giving twigs, however, to neighbouring muscles and inosculating with branches of the femoral artery.

The *Superficial* branch inclines outward between the glutæus maximus and the glutæus medius, and is there resolved into a multitude of twigs, some of which perforate those muscles, while others are appropriated to the sacro-sciatic ligament or anastomose with the sciatic artery.

4. The Umbilical Artery, (Arteria Umbilicalis.) This vessel, usually arising close to the origin of the last, directs itself forward and inward, till it encounters the side of the bladder. It then curves upward and ascends behind the anterior walls of the abdomen, a little obliquely toward the umbilicus, and approaching its fellow of the other side. In its ascent, it is involved in a duplicature of the peritoneum.

It is only in the fœtus that the artery thus exists. It is then of large size, being the hypogastric continued, and issues from the umbilicus to form a part of the funis, and through it, after many doublings upon itself, to reach the placenta. In the adult, this vessel ceases to be pervious between the bladder and umbilicus, being converted into a hard ligament which is seen folded in the peritoneum. Between the bladder and its origin it is still pervious, but its coats are exceedingly thick and rigid, giving to the artery a ligamentous feel. It here gives a few twigs to the bladder and uterus.

5. The *Vesical Arteries*, (Arteriæ Vesicales.) These small vessels are very inconstant in regard to number and origin. Some of them spring from the umbilical, while others are branches of the middle hemorrhoidal, internal pudic and obturator. But the most considerable branch usually springs from the Internal iliac and passes to the fundus of the organ, distributing its numerous branches to it—to the prostatic

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To secure this vessel,—place the patient on his face, and render the fibres of the great gluteus muscle tense by turning the knee and toe inward. Then draw an incision from a point an inch below the posterior spinous process of the ilium, and about an inch external to the side of the sacrum, in a line toward the great trochanter. The extent of this incision may be three or four inches. The skin and a large volume of cellular tissue will be first divided, when the coarse fibres of the gluteus maximus will be brought into view, they being parallel to the direction of the incision. The muscle is then to be incised, the operator endeavoring to separate its fasciculi, rather than to divide its fibres. This being effected, we encounter the loose tissue on which this muscle glides, directly over the seat of the artery, where it emerges from the pelvis, turning over the margin of the ischiatic notch, above the pyriform muscle. The fasciculi of the muscle must then be strongly retracted with the usual instruments; and, in order that this may be done with the less difficulty, the toe and knee may be made to present more directly forward. Besides the loose tissue here situated, there is a dense fascia which binds down the artery: this is to be cautiously separated, the operator avoiding to wound the numerous branches which here arise from the abrupt axis of the artery sought. It is to be borne in mind that the artery is associated with a nerve and a vein, which are to be carefully separated in applying the ligature. The passage of the thread will best be effected by the same instrument employed for the ligature of the subclavian.

This systematic anatomical method of proceeding, will, however, by the circumstances of the case requiring the operation, generally be rendered impossible. Diffused blood, or a circumscribed aneurismal tumour, will greatly increase the volume of the parts and disturb their relations. It is undoubtedly more feasible, therefore, in nearly all cases, to secure the internal iliac in the manner directed above. A case similar to that of Mr. John Bell would probably now be treated by the application of the ligature to the internal iliac, the sac of the aneurism being left entire.

portion of the urethra, the prostrate gland, the vesicula seminalis and vas deferens. Some of its twigs communicate with those of the rectum.

6. The Obturator Artery, (Arteria Thyroidea.) This artery is destined to supply the muscles situated around the thyroid hole. Its place of origin is very inconstant. Usually it springs either from the hypogastric or the glutæal, but not unfrequently it comes from a very different source, being a branch of the epigastric. When, from the former origin, the obturator passes forward and outward—then inclines more forward, passing like a chord across the lateral region of the cavity of the pelvis, involved in loose adeps, and finally, together with the obturator nerve, reaches the upper part of the thyroid opening, above the obturator muscle. Here it finds a hole in the ligamentous membrane which closes this space and through it emerges from the pelvis to supply the muscles which arise from the thyroid ligament and its vicinity. Near its origin it throws off laterally a branch into the iliac fossa to supply in part the iliac muscle. As it passes on, it gives twigs to the obturator internus muscle, to the neighbouring glands, and to the bladder. Just before it emerges, it gives origin to a branch which passes behind the symphisis pubis, gives twigs to the periosteum, and inosculates with a corresponding branch from the opposite side.

After issuing from the cavity of the pelvis, the obturator is resolved into two branches, the *anterior* and the *posterior*. The *posterior* skirts the outer edge of the thyroid opening, and descends between the two obturator muscles as low as the tuber of the ischium. Then it inclines outward, beneath the quadratus femoris m. reaches the posterior region of the thigh, and gives twigs to the hip-joint. One ramulus enters the cavity of the capsule, through the inferior notch, and ramifies in the fatty substance which is lodged in the bottom of the acetabulum. The *posterior* branch also inosculates with the sciatic artery.

The *Anterior* branch dips down between the first and second adductor muscles, and inosculates with a branch of the internal circumflex. In its course it gives twigs to all the adjacent muscles—the pectineus, gracilis, adductors, &c. and to the integuments. One twig skirts the inner border of the thyroid hole, anastomosing below with the posterior, thus forming an arterial circle around the margin of the opening.

When the obturator artery arises from the epigastric, it comes off from that vessel at the distance of an inch, or an inch and a half from its origin. It makes a large angle with its parent trunk, and, curving a little, passes inward, backward and downward, behind the os pubis to the hole in the thyroid membrane.

An instance of very unusual and interesting distribution of arteries in this region occurred to me two years since. Instead of the obturator being given off by the epigastric, the relation was reversed, the latter vessel giving origin to the former. The obturator arose from the internal iliac at the usual place, and, as it approached the thyroid hole, sent off the epigastric artery directly upward on the inside of the crural ring, six lines within the usual course of the artery. There was a very small branch of the external iliac in the usual place of the epigastric. The crural ring, therefore, had an artery on each side of it. A similar instance is related by Velpeau, and a third fell under the observation of my friend Professor Knight, of Yale College, who now has the preparation in which it is seen.

5. The *Middle Hæmorrhoidal Artery*, (Arteria Hæmorrhoidalis.) This vessel is often absent in the male; sometimes in the female. It is far from being uniform in magnitude or origin, sometimes springing from the ischiatic—sometimes from the internal pudic. It passes inward and downward, behind the bladder in the male, and behind the vagina in the female; and, on the anterior part of the mid portion of the rectum, is resolved into numerous twigs, which embrace the intestine, and inosculate above and below with the superior and inferior hæmorrhoidals.

6. The *Uterine Artery*, (Arteria Uterina,) usually springs from the hypogastric, either by itself, or in common with the umbilical. Sometimes it comes from the internal pudic. First, it seeks the upper part of the vagina, insinuating itself between it and the bladder, giving twigs to both. It then enters the broad ligament of the uterus, and meanders from below upward, along the margin of the uterus, in an extremely tortuous course. As it thus passes, it is constantly imparting to the organ numerous twigs, which insinuate themselves beneath the surface of the organ and meander transversely over its body, inosculating with corresponding opposite twigs. Ramuli also pass to the ligamentum teres and to the ovary, and there inosculate with the spermatic arteries. Where the artery first reaches the vagina, there is usually a branch given off,

which traverses the whole length of that organ. This vessel varies in its magnitude in correspondence with the development of the uterus in its different states.

7. The *Vaginal Artery*, (Arteria Vaginalis.) This vessel may arise from the hypogastric, pudic, umbilical, obturator, or hæmorrhoidal artery. In its descent it inclines forward, giving a twig to the bladder. It then traverses the side of the vagina, as far as to its orifice, giving to it numerous ramuli, and sending twigs to the nymphæ, labia, &c.

8. The Ischiatic Artery, (Arteria Ischiadica.) This artery usually arises from the extremity of the hypogastric, but sometimes it has a common trunk with the glutæal. In regard to direction, it is the continued trunk of the hypogastric. Its direction is downward, between the rectum and the walls of the pelvis. It passes in front of the pyramidal muscle, thus interposing that muscle between itself and the trunk of the glutæal artery. It then emerges from the pelvis at the lower part of the sciatic notch, beneath the margin of the pyramidal muscle, and above the anterior sacro-sciatic ligament. The great sciatic nerve, which issues from the pelvis at the same place, is situated behind and close to it. The direction of the principal branches of the ischiatic A. is then downward, to supply the lower portion of the glutæi muscles, and the superior posterior region of the thigh.

In the pelvis the I. A. gives twigs, variable in number, magnitude and arrangement, to the rectum, bladder and uterus. It also, in part, supplies the levator ani muscle. The hæmorrhoidal and obturator arteries, already described, are sometimes branches of the I. as is also, very frequently, the pudic, soon to be described.

As it emerges from beneath the pyramidal muscle this vessel gives origin to many considerable branches. The most important courses along beneath the origin of the glutæus maximus, to where this muscle is attached to the os coccygis. It is there resolved into branches which supply the levator ani and coccygeus muscles; first giving twigs, in its descent, to the glutæus muscle. Another branch directs itself toward the tuber of the ischium, supplying the lower portion of the glutæus maximus. The third branch is the one which may be regarded as the I. continued. It follows the sciatic nerve to the upper region of the thigh, giving twigs to all the muscles which arise from the tuber of the ischium and its vicinity—the quadratus femoris, the biceps cruris, the membranosus and tendinosus. It anastomoses with the muscular branches of the femoral artery.

9. The *Internal Pudic*, (Pudica Interna.) This important vessel is most frequently one of the terminal branches of the internal iliac, but very often it is the most considerable branch of the last described. In the former case it leaves the ischiatic, near the border of the pyramidalis, and descends before that muscle and

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Ischiatic Artery. The surgeon rarely has occasion to approach the trunk of this vessel. It is possible, however, to expose and secure it by an operation, slightly varying from that which is performed upon the glutæal. It issues from beneath the pyriform muscle, about an inch below the last-named vessel. Consequently the line of the incision should be at the same distance below that of the former, and parallel with it, in order to coincide with the fibres of the glutæus. This vessel will be found beneath the piriform m. descending toward the thigh, and overspread by a fascia which appears to pass off from the margin of the last named muscle. The general remarks which we have made in regard to the ligature of the glutæal, are predicable also of this vessel.

Pudic Artery. This vessel is concerned in one of the most important and interesting operations in surgery—that of lithotomy, being not unfrequently wounded by the knife or gorget, and requiring the ligature. Hemorrhage from it has sometimes proved fatal under those circumstances, and always its injury is attended with extremely unpleasant consequences, since there may be much blood lost before the vessel is secured, and since the extraction of the stone must necessarily be delayed while the ligature is applied.

That part of the trunk of the pudic artery which is exposed in lithotomy is its anterior portion, opposite to the anterior part of the anus, and near where it is giving off the transversalis perinæi. Here the vessel lies close to the internal face of the ischium, in some degree protected by a rough margin, or lip, which bounds this surface below and

Pl. 13.

Drawn on Stone by S. Smith

G. Willig's Lith

in front of the sciatic plexus. It leaves the cavity of the pelvis very near the exit of the last described vessel, between the pyramidal muscle and the posterior edge of the levator ani. It then bends inward as it descends, and insinuates itself obliquely between the two sacro-sciatic ligaments, partly winding round the the superior ligament. It then applies itself obliquely to the internal face of the ischium, and buries itself between the levator ani and obturator muscles. Thence it passes almost horizontally forward and inward, along the inner concave surface of the tuber ischii, to near the origin of the transversus perinæi, where it is resolved into two branches, the *inferior* and the *superior*. In pursuing the course just described, the pudic gives origin, before leaving the pelvis, to vesical branches—to twigs, which supply the vesiculæ seminales and prostrate gland, the prostatic and membranous portions of the urethra, the rectum, and, in the female, to the superior portion of the vagina. Sometimes the middle hæmorrhoidal and the obturator spring from its trunk.

Where the pudic is approaching the ramus of the ischium, and before it divides, it imparts, within, several small twigs to the loose and abundant fatty tissue which surrounds the rectum. Externally it sends others to the parts which cover the tuber ischii, and some along the muscles which arise from that bone.

Of the two branches into which the P. is resolved, the *inferior* is the smaller and least important. It immediately approaches the skin and meanders beneath it, over the transversus perinæi muscle, in the angular space intervening between the corpus cavernosum and the bulb of the urethra, supplying the fatty substance of that region. As it advances it bends inward, toward the raphe, giving anterior twigs to the sphincter muscle and to the transversus perinæi; but it is chiefly designed to supply the erector penis and the accelerator urinæ muscles—the cellular tissue, and the skin of the region—and finally the rectum, to the inferior extremity of which it sends some small branches denominated inferior hæmorrhoidal, and which anastomose with the twigs of the middle hæmorrhoidal.

One superficial branch of this artery is continued forward, beneath the skin, till it reaches the raphe of the scrotum, where, under the name of *artery of the septum scroti*, it supplies the dartos muscle, the septum, the integuments, &c. &c.

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projects a little inward. It is also bound down and further protected in this situation by the aponeurotic obturator fascia, which is attached to the margin of the bone.

In performing the modern operation with the gorget, the P. A. is more exposed than by the older methods of lithotomy; though the most important improvement effected, is the making of a free incision in the vicinity of the hip, between the tuber of the ischium and the rectum, by which a sufficient opening is made in a wide portion of the pelvis for the extraction of a large stone without the infliction of violence upon the parts which are situated higher in the arch of the pubes. This advantage, however, compromits, in some degree, the security of the pudic artery; but this is of far less injurious consequence than the violent efforts which might otherwise be necessary to extract the stone. When proper caution is observed, however, the artery may be avoided, although an extensive incision be necessary.

The instrument which most frequently inflicts injury upon the P. A. is the cutting gorget. The extent of the incision being determined entirely by the breadth of the gorget, is not at all under the control of the hand of the operator when the instrument is pushed forward upon the staff. The breadth of the incision must be uniform throughout; nor can its direction be varied at different points, as the relations of parts may require. Often, when the gorget is employed, as soon as the operator has fixed the beak of the instrument in the groove, he depresses the handle, in order

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INDEX TO PLATE XIII.—Fig. 1, Apex of the Os Coccygius; 2, 2, Tubers of the Ischia; 3, 3, Rami of the Ischia; 4, 4, Sacro-sciatic Ligaments; 5, 5, Coccygeal muscles; 6, Anus; 7, Sphincter Ani muscles; 8, 8, Levatores Ani muscles; 9, 9, Transversi Perinæi muscles; 10, Corpus Spongiosum; 11, 11, Superior margins of the Accelerator muscles; 12, 12, Erectores Penis muscles; 13, 13, Internal Pudic Arteries; 14, branch to the Rectum, Levator, and Anus; 15, Transversalis Perinæi A.; 16, branch of the Inferior Ramus to parts covering the Ischium; 17, branch of the Inferior to the Accelerator; 18, branch of same to the Scrotum; 19, Pudic continued; 20, Inferior Ramus.

The *superior* branch is very interesting and important in its relations. It creeps along the inside of the ramus of the ischium, concealed, at first, by the origin of the transversus perinæi;—then it rises above that muscle, and merges itself behind the erector penis. At length it reaches the triangular space which separates the corpora cavernosa from each other, below the arch of the pubes. Here it is resolved into two important terminal branches—the *dorsal artery of the penis* and the *artery of the corpus cavernosum.* Before this final division, however, it gives rise, near its origin, to the

Transversalis Perinæi. This vessel passes inward and a little forward, covered by the transversus perinæi muscle, toward the bulb of the urethra, to which body it is appropriated, being first resolved into several branches. It also imparts a branch to the corpus cavernosum, and anastomoses freely with the proper artery of that body. Often, instead of the continuation of the T. P. into the bulb, there arises a distinct branch (artery of the bulb,) from the pudic, high in the arch, opposite to the bulb, and which passes inward to that body, involved in the triangular ligament.

Beyond the origin of this last, the superior branch of the P. gives origin to twigs, some of which wind round the ramus of the ischium to the obturator internus muscle, while others are given to the glands of Cowper and to the erector penis muscle.

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to prevent the slipping of the gorget from the groove of the staff, and thus elevates the beak of the instrument until, perhaps, it makes too obtuse an angle with the staff. Then, when it is urged forward, the staff is forced upward into the angle of the pubes; consequently the gorget cuts higher in the arch than is designed, and where the crura of the ischia are approaching each other. I have heard of an operator, who, in this manner, used such severe pressure upon the staff as often to bend that instrument in passing the gorget. I am confident that this is not an ideal error, since, in the second instance in which I performed lithotomy with the gorget, it was committed by myself. I depressed the handle of the gorget so low, from fear of its slipping from the groove, the circumstance which I most feared, that at first it would not pass at all, a difficulty which caused me much perplexity. When the incision was finally effected, it was made so high in the angle of the pubes, that the stone was grasped with some difficulty, and not removed with as much facility as is usual. The pudic artery, however, escaped, as I was particularly careful to direct the angle of the gorget obliquely outward and downward. No serious mischief of any kind, indeed, was inflicted upon the patient, who ultimately recovered.

Having learned from the above case, that, in the use of the gorget, Scylla was on one side and Charybdis on the other, I resolved never again to employ that instrument, and have ever since made all my incisions with the knife.

From the manner in which the P. A. is partly sheltered by the inner lip of the margin of the ischium, and bound down by the obturator fascia which covers it, it often happens that when the artery is cut by the angle of the gorget, it is but partially divided. The bleeding is then apt to be very obstinate, and, if checked by any other means than the ligature, will certainly recur. When the vessel is completely divided, its extremity may retreat beneath its fascia, so that it shall be found with difficulty and not easily approached with the ligature. Its deep situation, (it being an inch and a half from the surface, also adds to the embarrassment. With the ordinary means it is, therefore, often very difficult to apply the ligature with precision. The forceps and needle, recommended by Dr. Physick for this purpose, will be found to meet the exigency of the case. The ligature is thus passed beneath the vessel so as to include some of the surrounding tissue.

In the employment of the scalpel or bistoury, for the deep incision in lithotomy, it appears to me that there can be but little danger of wounding the P. A. In the first place, the operator can with facility vary the obliquity of the incision at different points. He may even direct his knife parallel with the ramus of the ischium, where the P. A. is concerned, while he makes the incision in the prostrate nearly horizontal. Also, as the incision will generally be dilated when the knife is withdrawn, the handle being inclined to the left, the edge will so obliquely approach the ramus of the ischium that it will often encounter the ramus of the bone rather than wound the pudic artery.

Branches of the Pudic. *Transverse Artery of the Perinæum.* This vessel, although not of considerable magnitude, is important, because usually concerned in lateral lithotomy. It traverses the very centre of the region in which the incision is to be made for the extraction of the stone. It must, therefore, necessarily be cut in all cases. The

The *Artery of the Corpus Cavernosum* immediately pierces the side of the body to which it is appropriated, and is presently resolved into parallel branches, which traverse the whole length of the organ, giving off short branches in every direction, which subdivide to extreme minuteness on the septa of the corpus cavernosum. Some of them pierce the fibrous expansion of the cavernous body and penetrate the corpus spongiosum.

The *Dorsal Artery of the Penis* ascends between the crura of that organ, perforating its suspensory ligament and mounting upon the dorsum of the penis, along which it runs parallel with its fellow of the

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importance of a wound of this vessel depends upon the distance of the cut from the origin of the artery. This, we know, is deep beneath the perinæal fascia and the transverse muscle. There the artery, springing from the pudic, descends towards the skin, winding round, or perforating, the origin of the transverse muscle. Then it runs inward and a little forward, nearly parallel with the muscle and upon its cutaneous surface, towards a point mid-way between the bulb of the urethra and anus. The artery is accompanied by small nerves;—in its passage it is rapidly diminished by imparting branches to the parts which it traverses.

If the vessel be wounded in the mid-space between the rectum and tuber of the ischium, the hemorrhage is trivial, not requiring that the operation should be suspended while the vessel is secured, and usually ceasing spontaneously before the stone is extracted. But if it be wounded near to its origin by a broad lateral incision, such as is made when we expect to encounter a large calculus, the dash of blood is considerable, and the depth of the vessel such that it is not always promptly seized. I have seen it bleed so freely, under such circumstances, that some of those present judged it to be the pudic which was wounded.

In all cases the vessel should be carefully sought for after the extraction of the stone, and, if it can be found, should always be secured, even if no blood be flowing at the time, since, after reaction has taken place, and warmth is restored, hemorrhage may recur.

Artery of the Bulb of the Urethra. This branch, it will be remembered, arises from the pudic, high in the pubic arch, opposite to the bulb. It is consequently very short, and its course is transverse. It is involved in the laminæ of the triangular ligament, and lies deep—an inch or more from the surface.

When, in lithotomy, the operator makes his external incision too high, and then, as the patient lies, strikes for the membraneous portion of the urethra in a direction too nearly horizontal, instead of approaching it obliquely from below, the artery will usually be wounded. This is a circumstance always to be deprecated, because of the deep and confined situation of the artery, and because, being embraced by the triangular ligament, it cannot retract, and may bleed some hours after the operation. It is far better to secure this vessel, if it be cut, immediately after the extraction of the stone, before the blood has begun to coagulate within the wound, or in the cellular tissue. If the operator is conscious of having cut a little too high, and if, from the superior angle of the wound, a dash of blood has occurred at the moment of cutting for the membraneous portion of the urethra, there is reason to believe that the artery of the bulb is divided, and it should be carefully sought for before the patient is placed in bed.

But if the vessel cannot then be found, and if bleeding should recur after some hours, the operator will sometimes be foiled in attempting the application of the thread. If the patient has suffered much irritation from such attempts, and if blood is still flowing with alarming rapidity, compression must necessarily be resorted to. With this, however, if managed in the usual way, there is danger of obstructing the free discharge of urine, from which the most disastrous consequences may result. This danger may be obviated by first introducing a large gum-elastic canula through the wound into the bladder, and inserting a piece of sponge above this. The compress will act with the more effect from being supported by the firm canula. Mr. Harrison advises that the canula should be through a piece of sponge, and then introduced in such a manner that the sponge attached to it shall expand in that part of the wound into which the vessel opens. But, if possible, the operator should forestall the necessity of introducing any foreign substance into the wound, or into the bladder, by securing the vessel with the ligature.

Dorsal Artery of the Penis and *Artery of the Corpus Cavernosum.* These vessels are concerned in the amputation of the penis, and usually require to be secured with the ligature. When the operation is performed high upon the organ, the collapse and retraction of the crura and of the spongy body, immediately bury the arteries beneath the loose integuments. This retraction does not suppress the bleeding, because it rather prevents the recoil of the arteries them-

other side. It pursues a tortuous course, giving twigs to the loose integuments which involve it—to the fibrous covering of the corpus cavernosum, and finally terminating in ramuli which are lost in the prepuce. Near the duplicature of the prepuce, the two arteries anastomose by lateral branches, and thus form an arterial circle around the glans.

In the female, the distribution of the pudic artery is necessarily different from that in the male. The *inferior* branch gives ramuli to the transversus muscle, to the sphincter ani, and the constrictor vaginæ, and is finally lost in the labium. The branch corresponding to the *superior* in the male, ascends as in the latter, along the ischium and pubis, to the angular space between the crura of the clitoris. It supplies in part the vascular tissue which surrounds the orifice of the vagina, and is then resolved into a dorsal and a cavernous branch corresponding to the terminal branches of the same artery in the male.

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selves into the parts which immediately invest them. The hemorrhage, therefore, may be obstinate, and the bleeding orifices very difficult of access.

To obviate this difficulty, modern surgeons of eminence have advised, that, in severing the organ, we should first make a transverse cut upon the dorsum, only sufficiently deep to divide the dorsal arteries, which are then to be secured. Then the knife is to be carried more than half through the corpus cavernosa, when their vessels will spring, and are also to be secured. The organ may then be severed with safety. It is, however, only when the amputation is performed high upon the organ that all this is necessary.

I have known troublesome bleeding to arise from the division of the arterial circle which surrounds the penis in the root of the prepuce, in the operation for the relief of phymosis. The integuments are so loose that they retract more than the artery, and I have twice known a patient to bleed from this minute vessel till exceedingly exhausted. It ought always to be secured when divided.

Harrison, Burns and Haller mention a very interesting deviation from the ordinary mode in which the parts supplied by the pudic artery are furnished with blood. In several instances, the pudic has been found to be unusually small, and, in such cases the internal iliac has been found to give origin to a distinct branch, which ran along the side of the bladder and prostate gland and passed beneath the arch of the pubes, together with the dorsal veins, to become the dorsal artery of the penis. It the lateral operation of lithotomy, in which the incisions are freely made for the purpose of extracting a large calculus, it is obvious, that this vessel would be exposed to injury, and it is conjectured that, in some of those instances in which fatal hemorrhage has occurred after this operation, the bleeding has been from this vessel.

Hæmorrhoidal Arteries. It will be borne in mind that the arteries of the rectum are derived from three sources—the inferior mesenteric, the hypogastric, and the pudic. Those derived from the latter source, are small, compared with those coming from the two former; they reach the rectum near the anus and inosculate closely around it. They must, therefore, necessarily be always concerned in the operation for fistula in ano. Sometimes these vessels require the ligature. When the incision is made unusually deep along the rectum, the lower anastomosing branches of the middle hæmorrhoidal, are sometimes wounded. This, however, will rarely occur in the hands of the prudent surgeon. It is now ascertained, that it is rarely necessary to do more with the knife in this disease, than to divide the sphincter muscle and the inferior portion of the rectum.*

By some surgeons, rules very unnecessary, as it appears to me, have been given for exposing and securing the pudic artery, near the spinous process of the ischium. If the artery be wounded below this point, it would certainly be more practicable to secure it where injured by dilating the wound; since there is no portion of the vessel below the spine of the ischium, which is not more accessible than that for which it is proposed to cut.

In a case of sloughing ulcer of the glans penis, from which there occurred an alarming hemorrhage, Mr. Travers, of St. Thomas' Hospital, London, adopted the following expedient. He placed the patient on a hard bed, and behind each spinous process of the ischium, placed a piece of cork, so adjusted as to press the pudic artery upon that point of bone. This, as Mr. Harrison informs us, was attended with a very happy result.† It is highly probable that it may be found useful in other similar cases.

* Shaw's Manual of Anatomy.

† Harrison's Surgical Anatomy of the Arteries, vol. 2, p. 109.

The External Iliac Artery, (Iliaca Externa.) We have spoken of the division of the common iliac, at the sacro-iliac junction, into the external and internal iliacs, the former of which we have described. We now return to the latter, which appears to be the main trunk continued, whether we regard its magnitude or direction. The external iliac descends obliquely outward along the anterior and inner part of the psoas muscle. Its course is often perfectly straight, though generally it is a little inflected toward its fellow of the other side, and sometimes it is somewhat sinuous. Its course, for a small distance, is nearly coincident with the linea ileo-pectinea, but as it passes forward it diverges externally from that spine. It terminates at the middle of the crural arch, where the trunk emerges from the abdomen and becomes the femoral artery. As it descends, it at first lies obliquely on the iliac vein; but lower it gets to its outside, lying, however, in close contact with it. It rests also, in part, upon the psoas muscle, getting more in front of it as it descends. Anteriorly, it is loosely invested by the peritoneum. It is also enveloped in a scanty covering of cellular tissue, and is bound to the subjacent parts by a thin transparent lamina of the ileo-vesical fascia, which envelopes both it and the vein. The anterior crural nerve descends nearly parallel with the inferior portion of this artery, but is separated from it by the psoas muscle. The nerve, also, lies behind the plane of the artery, embedded between the psoas and the iliac muscles, closely bound down by the entire iliac fascia. Small twigs of the nerve more closely accompany the artery, sometimes crossing it. A leash of absorbent vessels accompany the iliac artery in its descent. They are chiefly situated on the inner side of the artery, but some of them obliquely encircle it. Small lymphatic glands are distributed along this plexus of absorbents.

Until it approaches the ligament of Poupart, the external iliac gives origin to but few small branches, and those are chiefly appropriated to the psoas muscle, the peritoneum, the lymphatic glands and to the

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External Iliac Artery. Like that of all the other great arterial trunks, the surgery of the external iliac is of modern date. When aneurism occurs in this vessel, it, more frequently than otherwise, locates itself near Poupart's ligament and at the origins of the epigastric and circumflex iliac arteries. In addition to the common symptoms of aneurism, which will here be strongly expressed, there are characteristic traits of the local disease, derived from the peculiar anatomical relations of the artery.

There occurs a firm pulsating tumour in the iliac fossa. Its hardness is more remarkable than that of most aneurisms, because of its being lodged in the fossa of a bone, and of its being embraced anteriorly by the muscular walls of the abdomen and the tendonous aponeurosis of the external oblique muscle. By the irritation and pressure which the tumour inflicts upon the psoas and iliac muscles, these organs are made to contract and permanently flex the thigh upon the pelvis. By the pressure of the tumour upon the iliac vein, the return of blood from the inferior extremity is impeded; the absorbents are obstructed in a similar manner, and hence result tumefaction and œdema of the member. The anterior crural nerve being sometimes encroached upon, a neuralgic state of the anterior muscles of the thigh may result, or partial paralysis. It is obvious that many of these symptoms might arise from disease and enlargement of the iliac glands.

To Mr. Abernethy is due the honour of having first successfully applied the ligature to the external iliac artery, for the cure of aneurism of its femoral continuation. Although the method practiced by that eminent surgeon is not now generally regarded as the most eligible, yet we should do injustice to his reputation in omitting a description of it.

Mr. Abernethy's first operation on the iliac artery, was performed in 1796. An incision was made through the integuments of the abdomen directly over the course of the artery and parallel with it, to the extent of three inches. The tendon of the external oblique being thus exposed, was divided upward in the direction of the incision, to the extent of two inches, beginning at Poupart's ligament. The operator then, to protect the peritoneum, insinuated his finger beneath the margins of the internal oblique and transversalis, and divided them in the same direction. The peritoneum with its contents was then carefully pressed upward and inward, and the operator immediately seized the artery with his thumb and finger. Mr. A. then cautiously separated the vessel from the contiguous vein with his finger, conveyed his ligature beneath it with a common surgeon's needle, and tied it about an inch and a half above Poupart's ligament.

cellular tissue of the iliac fossa. As it emerges from the abdomen beneath the crural arch, the external iliac gives origin to two considerable branches.

The *Epigastric Artery*, (Arteria Epigastrica.) This vessel is destined to supply the anterior muscular parietes of the abdomen, and to form important inosculations with the subclavian. It is uniform in its magnitude, and very constant in its place of origin, though sometimes, as I have remarked in describing the obturator, springing from the hypogastric.

The E. usually springs from the ex. iliac, a quarter of an inch above the ligament of Poupart. Sometimes, however, its origin is even below the crural arch, from the beginning of the femoral artery. When it rises at the point first mentioned, it abruptly bends downward to the ligament of Poupart;—then it is inflected upward and forward, thus forming a curve of small radius, the convexity of which presents downward. When it springs from a lower point it gains the anterior walls of the abdomen by passing directly upward and forward. Having got between the muscular walls and the peritoneum, it bends a little inward and then passes rectineally upward and inward obliquely toward the border of the rectus muscle, directing itself toward a point a little below the umbilicus. On reaching the border of the rectus muscle, the vessel perforates the sheath of that organ, and is then resolved into numerous branches which insinuate themselves between the fasciculi of the muscle and ascend to inosculate with descending branches of the internal mammary and inferior intercostal arteries—also with twigs of the opposite epigastric.

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In his second operation, Mr. A. made his incision more than half an inch on the outside of the upper part of the abdominal ring, to avoid the epigastric artery. He was particularly careful to disturb the peritoneum as little as possible, but raised it far enough to reach the artery about two inches above Poupart's ligament. The artery was not separated by the finger with the same facility as in the former case, but the operator was obliged to make slight incisions through its envelopes, on each side. By means of an eyed-probe he conveyed two ligatures beneath the vessel—carried one upward and the other downward, as far as the artery had been denuded, and tied them, the vessel was then severed in the interspace.

Since Mr. Abernethy's first operation, many surgeons, both in Europe and America, have accomplished the same—some by methods different from that above described. The history of those operations does not come within the limits of our design; it will suffice, therefore, to describe the method of Sir Astley Cooper as being that which has often been practised with success, and which is, I believe, generally admitted to be preferable to any other.

An incision is made through the integuments from near the spine of the ilium, to the inner margin of the abdominal ring. The aponeurosis of the external oblique m. being thus exposed, is to be co-extensively divided; and on this being raised, the spermatic cord is seen passing under the margin of the internal oblique and transverse muscles. The internal abdominal ring, or opening in the transversalis fascia through which the cord passes, is situated exactly midway between the anterior spinous process of the ilium and the symphisis of the pubis. The epigastric artery is discovered ascending on the inner margin of this opening; the artery sought is directly behind the opening, and if the finger be gently urged through the ring, below the cord, it immediately encounters the vessel, which is easily recognized by its pulsation. The artery and vein are connected by dense cellular membrane which must be cautiously separated, if possible with the finger or handle of the knife, carefully avoiding to contuse the surrounding parts. The ligature is then to be conveyed around the vessel.*

In using the aneurism needle, I am persuaded that the direction usually given, to thrust the point of the needle between the vein and artery and to bring it out on the distal side of the artery, is erroneous. I have found by repeated trials, that, when passed in this manner, it is far more difficult to ascertain when the point entangles the vein, than when the needle is entered on the outside and brought up between the vessels. In the latter case we can feel the point as it rises, ascertain whether any thing is carried before it, and press it away with the finger. The vein and artery have an opportunity to retreat from before the instrument, and there is nothing firm against which they can be pressed and transfixed.

* Hodgson on Diseases of the Arteries, p. 421.

Drawn on Stone by S. Smith

G. Willig's Lith.

Near its origin and behind Poupart's ligament the epigastric gives origin to three branches, which sometimes arise by a common trunk. The first of these is the *spermatic* branch; it passes upward and outward and enters the inguinal canal to join the spermatic cord. The second branch runs backward along the posterior face of Poupart's ligament, and giving twigs to adjacent parts, anastomoses with the obturator. The third runs horizontally along the posterior surface of Poupart's ligament behind the symphisis pubis, and there inosculates with a corresponding twig from the other side.

As the epigastric ascends, it gives numerous small twigs to the fascia transversalis and to the transverse muscle.

Till it enters the sheath of the rectus, the course of the epigastric artery is between the transversalis muscle and the peritoneum, involved in laminæ of the transversalis fascia. Near its origin, where it bends inward after reaching the ligament, it arches over the iliac vein. It then passes in front of the vas deferens and is situated on the inner border of the internal abdominal ring. The vas deferens seems to hook round the artery, for it crosses it, behind, in an outward direction, and then, having gained the abdominal ring, it passes down in front of the artery in the inguinal canal, being separated from it by the peritoneum and the fascia transversalis.

As the artery ascends, it runs near, and almost parallel with, the inner border of the linea semilunaris. It is accompanied, usually, by one vein which lies on its pubic side—sometimes by two, one on either side.

Circumflex Iliac Artery, (Arteria Circumflexa Ilii.) This vessel, of nearly equal magnitude with the last, springs from the anterior and outer part of the iliac, usually a little lower than the epigastric; but sometimes directly opposite to it. It dips a little toward Poupart's ligament—then passes outward and upward invested within by the peritoneum, toward the anterior spinous process of the os ilium, bending a little upward along the outer edge of the iliacus internus muscle. Near the spinous process of the ilium, it directs itself more nearly backward, and pierces the transversalis abdominis to gain a situation between that muscle and the internal oblique. That which may be regarded as the trunk continued, (sometimes termed the *internal* branch,) passes for a short distance nearly parallel with the crest of the ilium and then ascends between the internal oblique and transversalis muscles to supply those organs, and to inosculate with the internal mammary, lower intercostal and lumbar arteries.

During the first part of its course, the C. A. gives small twigs to the peritoneum, the iliac fascia, the transverse and iliac muscles. Near where it plunges into the muscular walls of the abdomen, it sends upwards between the internal oblique and transverse muscles a considerable branch, termed the *external*, which supplies the contiguous muscles. Very frequently this branch does not exist, the anterior abdominal walls being supplied by ramuli which arise from the convexity of the continued trunk as it follows the margin of the ilium.

INDEX TO PLATE XIV.—No. 1 marks the Lumbar Vertebræ; 2, the Rectum; 3, the Bladder; 4, Tendon of the External Oblique Muscle; 5, the Scrotum; 6, External Abdominal Ring and Cord issuing; 7, spine of the Ilium; 8, Iliacus Internus muscle; 9, Psoas Magnus m.; 10, Psoas Parvus; 11, Sartorius; 12, Rectus Femoris; 13, Tensor Vaginæ; 14, Vastus Externus; 15, Cruræus; 16, Vastus Internus; 17, Pectineus; 18, Adductor Longus; 19, part of the great Adductor; 20, Semi-membranosus; 21, Gracilis m.; 22, Tendon of the Patella; 23, internal Condyle; 23, Head of the Tibia; 25, Tendon of the Gracilis attached to the aponeurotic involucre of the knee; 26, Tendon of the Adductor extended to the fascia of the leg; 27, Grastrocnemii muscles; 28, Patella; 29, Muscles of the leg; 30, Bifurcation of the Aorta; 31, 31, Primitive Iliac Arteries; 32, External Iliac; 33, Ilio-lumbar; 34, Circumflex Iliac; 35, Epigastric A.; 36, Branch to the Cord; (37, insertion of the Psoas Parvus;) 38, Femoral A.; 39, Superficial Muscular A.; 40, Profunda Femoris; 41, External Circumflex; 42, Internal Circumflex; 43, 44, 45, Perforating branches; 46, branch to the adductor m.; 47, Inferior Perforating; 48, Anastomotic; 49, Superior Internal Articular; 50, Inferior Internal Articular; 51, 52, Anastomoses of two former around the knee; 53, 55, External Pudic; 54, Superficial Abdominal; 56, Internal Circumflex; 57, Descending branch of the External Circumflex; 58, Superior External Articular; 59, Superior Internal Articular; 60, Inferior Internal Articular; (61, Suspensory Ligament of the Penis.)

The Femoral, or Crural Artery, (Arteria Femoralis.) This vessel, with but little diminution of magnitude, is directly continued from the external iliac; its name and relations being changed where it emerges from beneath Poupart's ligament to descend upon the thigh. The point at which the vessel com-

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The accompanying engraving illustrates Mr. Cooper's method of securing the external iliac on the right side. The artery is seen raised from between the nerve and vein—the nerve externally—the vein within. A slip of fascia is seen between the artery and vein on one side, and the artery and nerve on the other. A gland rests on the artery above. Externally the circumflex iliac is seen arising, and internally—the epigastric. The external part of the incision exposes the white surface of the tendon of the external oblique. The deeper portion exposes the fleshy substance of the internal oblique.

In the method of Sir A. Cooper, it will be observed, that although not so much of the length of the vessel is exposed, yet it is rendered much more accessible to the needle, because this instrument must necessarily be used transversely with respect to the artery. It will be observed also, that the fibres of the external oblique being separated longitudinally, and those of the deeper muscles not being wounded at all, the walls of the abdomen are nothing so much weakened as in the operation of Abernethy, and not so liable to permit the occurrence of herniary protrusion. Mr. Todd remarks that, although, in most cases, the operation of Mr. Cooper is to be preferred, that of Mr. Abernethy will be accomplished with most facility when it may be necessary to seek the superior part of the vessel. Also, when the operator has reason to fear that the external iliac may be diseased, and that it may be necessary to secure the common iliac, it may be advisable to employ Mr. A.'s method, which, it will be recollected, is similar to that recommended for securing the latter vessel.

As a modification of Mr. Cooper's method, I would suggest the propriety of making the incision through the aponeurosis of the external oblique in a line half an inch higher than that recommended by him. This artificial opening being then not coincident with the margins of the internal oblique and transverse muscles, will weaken the walls of the abdomen far less.

The ligature of the external iliac was first performed in this country by the late Professor Dorsey, of Philadelphia. It was performed in 1820, by my father, the late professor of surgery in Yale College, after the manner of Sir A. Cooper. The operation was accomplished with facility, and the patient promptly recovered. It has now been performed by many American surgeons and with more uniform success than generally attends operations upon arteries equally large.

Epigastric Artery. There is scarcely any vessel of equal magnitude in the human body, which is so frequently named in our systems of surgery as the epigastric artery; and yet it is rarely wounded, accidentally or in surgical operations. It bears, however, a very interesting relation to the neck of the sac, both in femoral, and inguinal hernia, and has sometimes been wounded in operations performed for relief of stricture in those diseases.

The reader will call to mind, that near the origin, the E. arches a little over the iliac vein, which lies on the inside of the artery, and consequently approaches the border of the crural ring, on the inside of the vein. The artery is situated above and on the outside of the crural ring. As it ascends, in the manner that we have described, it is situated just within the inner border of the internal inguinal ring. The artery is covered anteriorly by the fascia transversalis.

In inguinal hernia by the oblique descent, in which the tumour dilates the internal ring and follows the spermatic cord, it is obvious that the artery must ever be situated on the inside of the neck of the sac, however the relations of the parts may be disturbed in other respects. When, in old hernia of this species, the two rings have become so dilated, the one externally and the other internally, as to be nearly co-incident with each other, the epigastric artery will be thrust inward to the outer margin of the tendon of the rectus, will be wrapped around two-thirds of the circumference of the neck of the sac, and will be found involved in a dense ring of tissue. In ventro-inguinal, or direct hernia, in which the tumour ruptures or protrudes the fascia transversalis directly behind the external ring, the epigastric artery is always situated

mences its course is beneath the middle of the ligament of Poupart, and nearly midway between the anterior spinous process of the ilium and the spine of the pubes, a little nearer, however, to the latter. As it descends upon the thigh, it inclines obliquely backward on the inside of the plane of the femur, but approaches it as it descends, because that bone inclines inward. Its course is slightly spiral in relation to the bone. Having traversed two-thirds of the length of the thigh, it pierces obliquely the broad tendon of the adductor magnus and, thus entering the ham, becomes the popliteal artery.

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on the outside of the neck of the sac, encircling it, in old hernia of this species, as in the former variety. Such being the varying relations of this vessel to the neck of the herniary sac in inguinal rupture, we are advised, in making our incision for the relief of stricture, to carry the bistoury upward and a little inward, toward the umbilicus.

M. Velpeau states that he has occasionally seen a second epigastric arising from the external iliac, and ascending on the external side of the abdominal ring. This furnishes an additional reason for avoiding to cut outwardly in any form of inguinal hernia.*

In femoral hernia, the epigastric artery ascends on the outside of the neck of the sac, the viscus always insinuating itself through that portion of the crural arch which is occupied by the iliac vein, on the inside of the iliac artery. In old hernia of this variety, the artery may encircle a considerable portion of the neck of the sac;—hence the former precept, always to cut inward in relieving the stricture of femoral hernia. But it is now a familiar fact, that often† the *obturator artery* springs from the epigastric where it arches over the iliac vein, and takes a course obliquely downward, inward and backward, on the inside of the iliac, in its route to the thyroid hole. When this arrangement exists, it is manifest that the protruding viscus, following the vein, may insinuate itself into the arterial circle thus formed, and, at its neck, be almost entirely surrounded by arteries of considerable magnitude. I am persuaded, however, that in many cases, perhaps a majority of them in which the obturator thus arises, the vessel lies so closely applied to the vein that the herniary tumour will pass on the inside of the artery, and thus place it, with the epigastric, on the outside of the neck of the sac. This I have heard stated by Professor McClellan, of Philadelphia, who exhibited a preparation illustrative of the fact.

In describing the obturator artery, (p. 103.) I have stated that, in some rare instances, the epigastric is produced from this vessel, and ascends on the inside of the femoral ring. In such a case, a small epigastric exists in its usual place; thus we have an artery on each side of the ring. For the above reasons, therefore, we have the same precept as in inguinal hernia to cut to small extent, obliquely upward and inward, for the relief of stricture. If the obturator exists and encircles the neck of the sac, the bistoury will enter the angle which this vessel makes with the epigastric and be less apt to inflict injury than in any other direction.

Even when the obturator does not arise from the epigastric, there exists, as we have before described, a branch of the epigastric descending along the posterior face of Poupart's ligament and on the inner side of the iliac vein, to anastomose with the obturator. This vessel, though not considerable, it is desirable to avoid. Velpeau remarks that the pudic branch of the epigastric, where it runs close to the margin of Poupart's ligament, horizontally toward the pubis, and consequently above the sac, may be wounded by an incision directly upward, or upward and inward, and conjectures that, in the case related by Mr. Hey, in which that operator supposed that he had wounded the epigastric,‡ it was this small vessel which was injured. It is obvious, therefore, that the surgeon should use extreme caution in whatever direction he may see fit to make his incision. It is not the amount of blood lost in this operation which causes danger, but the effusion of it into the cavity of the abdomen.

In case the epigastric artery be wounded in paracentesis abdominis, in the operation for hernia, or by an accidental wound, it may, as a dernier resort, be approached and secured near its trunk by making an incision two inches in length, parallel to Poupart's ligament—its centre corresponding to that of the ligament. The internal ring may be exposed precisely as in cutting for the iliac artery, and the fascia transversalis forming its inner border being ruptured, the artery

* Treatise on Surgical Anatomy, vol. ii. p. 63.

† Monro met with this origin of the obturator in one out of twenty subjects—Burns in one of thirty—Scarpa and Lawrence in one of ten or fifteen—Cloquet in one of five. My own experience would confirm the latter.

‡ Hey's Surgical Observations.

In describing the relations of this important vessel, we regard it as traversing two distinct regions:—the first of these occupies the superior third of the thigh—the second, the middle third of that member.

The superior section of the vessel is lodged in what is termed the *inguinal triangle*. This space is bounded above by Poupart's ligament, which is its base—externally by the oblique border of the sartorious muscle and the rectus—internally by the adductor muscle, and inferiorly by the angle which these muscles make with each other. The floor of this region, on which the artery rests, is formed superiorly and externally of the psoas and iliac muscles, supported by the acetabulum and head of the femur—superiorly and internally by the pectinæus muscle—inferiorly by the adductor muscle. These muscles are overspread by the deep lamina of the fascia lata of the thigh, which closely adheres to them, and on which the great vessels immediately rest. The artery passes out of the pelvis on the inner border of the iliac and psoas muscles, which then abruptly recede from it and dip among the muscles of the thigh. As it emerges from beneath

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is found ascending beneath it and enveloped in firm tissue which rests on the peritoneum. This expedient will, however, rarely be resorted to, as a wound of the epigastric is usually concealed, and the bleeding insidious, till perhaps the patient is exhausted, or so much blood is extravasated in the abdomen that fatal peritonitis results.

Circumflex Iliac Artery. The surgical relations of this vessel are not important. We have seen, however, that it was wounded in Professor Mott's operation for securing the common iliac, (p. 98.) and that its bleeding gave some annoyance to the operator. Ramsay* relates a case in which the ascending, or external, branch of it was wounded in paracentesis, and caused dangerous hemorrhage. The vessel may also be wounded where it runs along the inner lip of the spine of the ilium, between the internal oblique muscle and the transversalis, without the walls of the abdomen being transfixed. Indeed, any wound of the abdominal parietes near the spine of the ilium, which shall give rise to considerable hemorrhage, may be supposed to have opened a branch of this artery.

It might be secured, near its origin, in a manner very similar to that advised for the epigastric. The incision should be made close to Poupart's ligament and parallel with it—its centre opposite the internal abdominal ring. The spermatic cord being exposed is to be pushed upward, the fascia transversalis ruptured at the outer border of the ring, and the artery will be found involved in strong cellular tissue and situated nearer to the iliac muscle than to the ligament. It may also be exposed near the anterior spinous process of the ilium, by first incising the tendon of the external oblique half an inch from the margin of the ilium, and parallel with it, and then cautiously dividing the fibres of the internal oblique, near their origin, and raising them from the transversalis on which they closely lie. The artery will be found about half an inch from the ilium bound down by the external fascia of the transversalis muscle.

In crural hernia, the circumflex artery aids to form the arterial areola which surrounds the neck of the sac in the chronic form of the disease. As the neck of the sac will thrust itself in front of the iliac artery, as it dilates the ring the circumflex iliac will necessarily be made to encircle the outer and posterior part of its circumference. It will be recollected that the spermatic artery, involved in the cord, is closely in front, lodged in the inguinal canal—that the epigastric is on the outside and in front, and that the obturator, or a small branch of the epigastric, is on the inner side.

It is highly important that, in performing the operation of securing the external iliac artery, the operator should be aware that both the epigastric and the circumflex iliac arteries vary in regard to their points of origin, and that the iliac has, by a fatal error, been tied just below the origin of the epigastric. This occurred in the hands of Beclard.† Let the surgeon be aware that sometimes the epigastric arises an inch above Poupart's ligament—at other times, a little below it. The circumflex iliac is more constant in regard to its point of origin, but sometimes varies. In denuding the iliac, the operator should, therefore, carefully feel for any adjacent branch.

From the anastomoses which we have pointed out between the epigastric and the intercostal and mammary;—between the circumflex iliac and the same thoracic arteries;—between the branches of the internal iliac and the lumbar twigs, it is manifest how nature can effect a collateral circulation between the superior and inferior regions of the body, even when the aorta becomes obliterated by the gradual encroachment of disease. Is is equally obvious that the circulation may be promptly restored after ligature of the common iliac, external iliac, or internal iliac.

* Treatise on Surgical Anatomy, vol. ii. p. 68. † Velpeau's Surgical Anatomy, Trans. vol. ii. p. 119.

Poupart's ligament, the artery rests also on the outer border of the pectinæus, over which it soon glides obliquely, and then rests entirely upon the anterior face of that muscle, a quantity of loose tissue, which involves veins and arteries, intervening. Quite low in this region it is anterior to the adductor brevis.

Anteriorly, the femoral artery, in this region, is quite superficial, being covered by no muscle till it insinuates itself obliquely beneath the border of the sartorius. It is covered first by the skin and subcutaneous fat;—next by the superficial fascia, prolonged from that of the abdomen, involving lymphatic glands;—finally, by the anterior laminæ of the fascia lata and the cribriform fascia.

As anatomical descriptions of this region vary, I must advert more particularly to the arrangement of these laminæ. In my demonstrations of this region I have always been able to display distinctly three layers of the fascia lata. One of these is superficial, existing only below the outer half of Poupart's ligament, and attached to that cord by a crescentic horn, the acute point of which runs inward toward the pubes and passes across the artery, covering only a small portion of it. The second lamina of the fascia is beneath this, and in contact with it. By a similar crescentic process it is attached, in the same manner, to the ligament of Hey, or the *femoral ligament*, described by Mr. Colles. It bears the same relation to the fascia transversalis that the external lamina does to the tendon of the external oblique muscle. If the handle of a knife be thrust from above downward, between the tendon of the external oblique and the fascia transversalis, it will readily pass between the ligament of Poupart and the femoral ligament, which is directly behind it. If the instrument be urged onward upon the thigh, it will separate that portion of the fascia lata which is generally described as being inserted into Poupart's ligament, into two laminæ.* It is the deeper of these that I am now describing. When we cut away that part of the ligament which is in front of the knife, we expose the femoral ligament and distinctly see the second lamina inserted into it precisely as the anterior is inserted into the ligament of Poupart, having the same crescentic form and insertion, and its margin nearly coincident with that of the former. It is more cellular and loose than the superficial. The crescentic points of both of these membranes, where they stretch along the two ligaments toward the pubes, cross the artery; but they are there very narrow, and the artery quickly emerges from beneath their margins.

FEMORAL ARTERY.

Femoral Artery. Mr. Harrison remarks,† that, immediately behind the psoas muscle, below Poupart's ligament, there is a large bursa mucosa, which, when inflamed and distended, protrudes the artery in some degree, or forms a tumour around it. This tumour may, in some respects, resemble aneurism, particularly as the protrusion of the artery will obstruct the passage of blood through the vessel, and thus increase its throb. By flexing the thigh on the pelvis and relaxing the psoas, the surgeon will readily discover that the characteristic traits of aneurism are not present.

Velpeau speaks of three modes of arresting the flow of blood through this vessel by pressure;‡ one by pressing the artery upon the body of the os pubis, where it emerges from beneath the ligament. The artery here has a little lateral mobility, and may sometimes evade the pressure; but the margin of the os pubis, separated from the artery only by the pectinæus muscle, furnishes steady resistance, which usually makes the pressure effectual, even when made by the thumb, or any instrument sufficiently broad to prevent the gliding of the artery. A counting-house seal may be employed for this purpose. The second method is to press the vessel a little below Poupart's ligament, backward and outward, upon the head of the femur; the thigh being extended. In the third mode the vessel is compressed upon the shaft of the femur, by directing the instrument outward and backward. Both the latter methods are difficult; and, as they require particular attitudes of the limb, are liable to be defeated, in the moment of necessity, by the action of the muscles. Compression of this vessel is sometimes practised in amputation of the hip joint—sometimes in amputation of the thigh. Permanent compression of the vessel upon the pubis has often been resorted to, as a substitute for the ligature, in case of aneurism. Guattani was thus successful. There is certainly no region of the body, except that of the arm, in which such an attempt promises more; but when we reflect that, even with the *bandage a pelotte of Brayer*, mentioned by Velpeau,

* This is by no means a "trick of the knife," as is suggested by Mr. Shaw, in his Manual of Anatomy, but can be accomplished with as much uniformity and precision as any other dissection.

† Surgical Anatomy of the Arteries, vol. ii. p. 148.

‡ Velpeau's Surgical Anatomy, p. 340.

If we trace these crescentic margins outward and downward, an inch or more, we find that the two laminæ become blended with each other. The single sheet which thus results, there curves inward, forming the lower horn of the crescent and completing a half oval. From this point it curves inward, upward and backward, upon a deeper layer of muscles, (the pectinæus, &c.) and, as it approaches Poupart's ligament, winds outward and sinks beneath the superior crescent—also, beneath the great vessels, and becomes the *third*, or *deep lamina* of the fascia lata, which covers the psoas muscle and is attached to the os pubis.

These laminæ, then, are continuous with each other, and exist distinctly only at the place where the great vessels issue, two being in front and one behind. Their coincident margins, which we have described, form an oval opening the border of which winds spirally deeper as we trace it outward, downward, inward, upward, and again outward, and its termination is nearly an inch deeper than its origin. This oval opening, where none of the true laminæ of the fascia are in front of the artery, is about an inch and a half in its vertical length, and about an inch broad. It is closed by a loose, filamentous fascia, which I term the cribriform,* although this appellation has often been applied to the middle lamina. This fascia adheres to the margin of the oval and covers the great vessels. It also adheres firmly to the superficial fascia; it involves lymphatic glands and a complicated tissue of blood-vessels, absorbents and nerves. The saphena vein passes over the inferior and inner border of the oval and pierces this fascia to reach the femoral vein.

The cribriform fascia adheres closely to the sheath of the great vessel;—the more so because it involves several of their small branches. At the inferior margin of the oval opening the artery passes beneath the united laminæ of the fascia lata.

At the lower extremity of this section of its course the vessel has the border of the sartorius muscle in front of it.

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we must necessarily compress the vein and absorbents, together with the artery, we can scarcely regard the attempt as admissible in any case. It is a reproach to French surgery that these expedients are still spoken of to the disparagement of the ligature.

There is no large artery the ligature of which is so frequently performed as that of the femoral. From its situation it is comparatively obnoxious to injury. It is also very frequently secured for the cure of aneurism of its popliteal continuation, on which aneurism more frequently locates itself than upon any vessel of its class. It will be remembered that it was by the operation performed upon this vessel, that Mr. Hunter confirmed perhaps the most important principle of modern surgery. The surgery of this vessel is, therefore, replete with interest.

There are three points, at each of which it may sometimes be necessary to secure the femoral artery;—where the vessels emerges from beneath Poupart's ligament—where it is approaching the border of the sartorius muscle—lastly, where it lies beneath that muscle and is approaching the hole in the adductor tendon.

It is not often at the first of these points that the vessel is secured for the cure of aneurism. When the popliteal artery is the seat of aneurism, this point is too remote for the ligature, and when the upper section of the femoral artery is concerned, it is too near to the disease. It is only when aneurism is located upon the inferior portion of the femoral artery, where embraced by the muscles in the middle of the thigh, that it is proper to secure the vessel below Poupart's ligament. Aneurism, however, in the region just mentioned, very rarely occurs; and even when it does, the prudent surgeon will often prefer to secure the external iliac, knowing that the profunda femoris often arises very near to Poupart's ligament, and that, in all cases, his ligature must be applied very near to the origins of the epigastric and circumflex iliac arteries.

In case the femoral artery be wounded below, and near to, Poupart's ligament, it is manifestly necessary that the vessel should be secured at the place of injury.

The precepts for securing the femoral artery in this situation are given in few words. A line drawn from a point a quarter of an inch within the centre of Poupart's ligament, toward the inner edge of the patella, will indicate, with

* Harrison's Surgical Anatomy of the Arteries, vol. ii. p. 145.

On the outer aspect of the femoral artery is situated, at the upper part of this region, first, the crural nerve, at a small distance removed; then the tendon of the psoas and iliac muscles, which intervene between it and the hip joint. Lower, the sartorius muscle is at some distance on the outside of it, and next it applies itself to the inner border of the rectus femoris.

Internally, the femoral artery first lies in contact with the femoral vein;—next with the pectinæus muscle, and lastly with the adductor longus, between which and the sartorius we find it lodged in the lower part of this section.

It is necessary to observe, that the relations of the femoral artery and vein vary as they descend along the thigh; for the latter winds spirally upon the inside of the artery, and, at length, where it merges itself beneath the sartorius gains a situation partly behind it. The artery and vein are involved in the same fibrous sheath, continued from that which envelopes the external iliac. This sheath is adherent to the inter-muscular fibrous septa, and thus securely fixed. Within their envelope the vessels adhere to each other by dense tissue;—much more closely at the inferior part, however, than at the superior.

The course of the saphena vein, as it ascends, exterior to the fascia, to join the femoral, is nearly an inch within that of the artery: though sometimes so near that surgeons have deemed it necessary to give directions for avoiding it in cutting for the artery. A branch of the crural nerve also passes down obliquely, in front of the artery.

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precision, the course of the vessel. Indeed, the vessel is here so superficial, that, in most cases, its pulsation will be a sufficient guide—one, however, never to be implicitly relied upon. The patient being placed in the supine posture, the thigh should be extended upon the pelvis, and the knee slightly everted. The operator commences his incision a little above the ligament of Poupart, and continues it downward upon the thigh, in the line described, to the extent of two or three inches, through the integuments and superficial fascia. The cribriform fascia, being thus exposed, is to be cautiously divided with the aid of the director. The glands and small vessels, which here present themselves, should be carefully detruded from before the vessel. Some small branches of the artery and vein will necessarily be divided, and may perhaps require the ligature. The sheath of the vessel, being now exposed, is to be carefully raised with the dissecting forceps and opened with a slight transverse cut, into which the director is conveyed. By the aid of this the sheath is to be opened to the extent of an inch or more. The operator may now place his finger directly upon the vessel. Its close connection with the vein suggests caution in effecting its separation, which may, however, be accomplished by the obtuse point of the aneurism needle. This instrument is, in my opinion, most safely conveyed from without inward, as it is thus easy to ascertain with the finger when the instrument insinuates itself between the two vessels, and very easy to divide the intervening tissue by cutting upon the point of the instrument. Far less violence will thus be done to the vessels than by pioneering with the handle of the knife, and lacerating their connections Generally the surgeon should endeavour to fix the ligature about three-fourths of an inch below the ligament; but caution is necessary to ascertain whether the profunda arises as usual, for sometimes this vessel leaves its parent trunk very near the ligament. When this is the fact, the ligature may be conveyed above the origin of the profunda, or may be applied an inch below it, as the case may require. It is also necessary carefully to identify the femoral artery; for, when the profunda is thus given off, as it is nearly as large as the femoral, it might be mistaken for it. The profunda is on the outside and deeper. They may be identified by compressing them successively and observing the effect on the pulse of the limb.

But the point at which it is generally most feasible and proper to ligate the femoral artery is near the margin of the sartorius muscle, and in the lower part of the first section of its course. This point is sufficiently near to the seat of popliteal aneurism to render the ligature effectual, and sufficiently remote from the tumour to obviate danger from disease of the artery. Hunter, it is true, in the first trials of his method, and before the effect of the ligature upon aneurisms had been fairly tested, deemed it necessary to apply the thread to the lower section of the artery. But subsequent experience has established the superiority of Scarpa's practice of applying the ligature near the border of the sartorius. While the vessel is here much more accessible, it is ascertained that the ligature to this section of it is

The relations of the femoral artery, in the second section of its course, are less complicated. Having entered between the adductor longus and the sartorius, the vessel is covered by a dense fascia, which stretches from the vastus internus muscle to the tendon of the adductor. Externally, the artery is here bounded by the vastus internus, and internally by the tendon of the adductor. Posteriorly, it rests in the angle formed by the union of these two, behind the artery. The femoral vein is here situated behind the artery. The saphenus nerve is in front and involved in the sheath of the vessels.

At the lower part of this section of their course, the femoral artery and vein become engaged obliquely in the broad tendon of the adductor muscle, which stretches along the linea aspera, forming a septum between the anterior and posterior regions of the thigh. The opening through which they effect their passage is not wholly in the tendon of the triceps adductor; the vastus internus forms its internal border. Its form is oval and its border tense and inelastic, for the purpose of preventing the infliction of any constriction upon the vessels.

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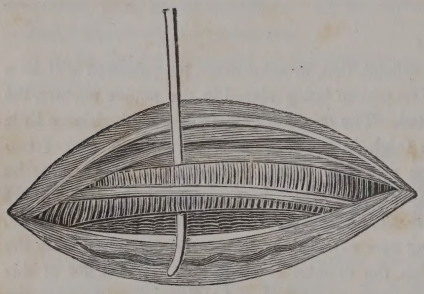
sufficiently near the seat of the disease to produce upon it all the usual salutary effects. The following is the most approved mode of executing the operation.



The cut represents the mode of exposing the femoral artery for the ligature, near the border of the sartorius, on the left side. The border of the fascia lata is seen, and within this that of the sheath of the artery. The crural nerve is on its outer side—the crural vein within. The border of the sartorius is exterior to the nerve. The vena saphena is seen within the inner border of the fascia, and more superficial than it. The saphenus nerve, as it often does, traverses the artery obliquely.

The patient being placed in the posture necessary for the operation, as above described, the course of the artery is ascertained as before. If a thread be drawn from the anterior spinous process of the ilium to the most prominent point of the inner condyle of the os femoris, the point at which it intersects the line indicating the course of the artery will correspond to that at which the artery merges itself beneath the margin of the sartorius. The operator commences his external incision two inches above this point, and continues it, on the line of the artery, an inch below the same. The fascia lata being exposed by the first stroke of the knife, is to be cautiously divided to the extent of an inch and a half. Beneath this a layer of dense membrane, which is spread over the sheath of the artery, is to be divided with the aid of the director. The finger then readily distinguishes the artery involved in its sheath. This envelope is to be opened as in the former operation, when the artery will be exposed. It is here found very closely adherent to the vein, which is now passing behind the artery. The former vessel throws some of its small branches around the latter, and thus renders the operation more difficult. I am persuaded that the aneurism needle is passed with most facility from without inward. We thus readily insinuate the point of the instrument into the interstice, between the artery and vein; and, by raising the point of the instrument, can, by applying the finger to it, ascertain with precision whether we have raised any portion of the artery or vein upon its point. A slight cut, made upon the point of the instrument, will enable us to pass the ligature without any laceration of the parts by the previous use of the finger-nail, or handle of the knife. The limb is then to be dressed in the ordinary manner and to be placed in a semiflexed position.

The importance of caution in separating the vein and artery, in this situation, may be inferred from the following: The late Professor J. K. Platt, of Vermont, informed me that he once witnessed the operation of tying the femoral artery by a distinguished surgeon in London. The edge of the knife having been used in separating the very close connection of the artery and vein, a small portion of the walls of the latter vessel was cut away, probably by severing one of the branches of the vein close to its parent trunk. The hemorrhage which resulted being troublesome, and not easily controlled by compression, the operator carefully hooked up the orifice of the cut and threw a delicate ligature around it. The wound was then dressed in the ordinary way. At the end of three or four days, unpleasant constitutional

The branches which derive their origin from the femoral artery are, 1st,

The *External Pudic*, (Pudica Externa.) These are two in number, of inconsiderable magnitude—the *superficial* and the *deep*. The former arises from the femoral, close to the ligament of Poupart. It passes transversely inwards, between the fascia lata and the skin, toward the parts of generation, and, as it approaches them, is resolved into two branches. One of these ascends upon the pubes, and is lost in the integuments of the abdomen, inosculating with the epigastric and superficial abdominal arteries. The other is appropriated, in the male, to the scrotum and integuments of the penis, being continued to the prepuce—in the female, to the labium pudendi.

The deep pudic arises from the femoral, a little lower, or even from the profunda. It at first descends a little, then turns inward, and passes transversely beneath the fascia of the thigh, which it perforates as it seeks the scrotum in the male and the labium pudendi in the female. It inosculates with the superficial branch.

The *Abdominal Subcutaneous Artery*, (A. Abdominalis Superficialis.) This long and slender vessel is very constant and uniform in its place of origin. It springs from the femoral, very near to Poupart's ligament;—sometimes above the ex. pudic, and sometimes below. It winds outward, and ascends, over Poupart's ligament, upon the walls of the abdomen; being situated between the tendon of the external oblique and the integuments, involved in the fascia superficialis. As it ascends it gives twigs to the glands of the groin and to the cribriform fascia—to the integuments of the abdomen—the fascia superficialis, and

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symptoms arose, together with an unfavourable aspect of the wound. These became rapidly aggravated, and the patient soon expired. Post-mortem examination revealed a high degree of phlebitis in the femoral vein as the cause of the fatal result.

Since the publication of the first edition of this work, I have secured the femoral artery for popliteal aneurism in five instances. My experience has taught me that the supposed difficulty arising from the close connection of the artery and vein, spoken of above, is for the most part a bug-bear. In the first instance, I did not pass the ligature with ease and promptitude, because I did not fairly enter the sheath of the artery with the knife. In the other cases I effected it with the greatest ease, being particularly careful to fairly open the sheath before I attempted to pass the needle. I then found it to glide round the vessel without the slightest impediment. From what I have seen and read of operations upon large arteries, I am inclined to think that the extreme caution with which the operator approaches the vessel and the timidity with which he opens the sheath is the most prolific source of difficulty.

It has been found that the cohesion of the artery and vein is less close a little above the point at which the ligature is usually applied—about an inch and a half above the margin of the sartorius. Should the surgeon, for this reason, prefer to denude the artery at that place, he will carefully bear in mind that he is approaching the profunda, and that often this vessel arises within two inches of the sartorius. It is incumbent on him, therefore, to examine the track of the artery for the bifurcation, and to apply his ligature never less than an inch below the origin of the profunda.

Should the surgeon cut too low upon the thigh, he will necessarily be embarrassed by the presence of the sartorius muscle lying over the artery, and which will require to be retracted externally or internally. To avoid this inconvenience Dessault advised the unnecessary expedient of dividing this muscle.

Mr. C. Hutchinson,* apprehensive that the incision along the inner border of the sartorius would endanger, either the saphena vein, or the lymphatics which ascend along that region of the thigh, advises that the incision should be made along the outer border of the sartorius. The embarrassments which must arise from such a mode of operating must be manifest, since the wound must necessarily be deeper, and the artery must be approached obliquely. Nor is the apprehension which suggests this method well founded. The saphena rarely, if ever, lies so coincident with the artery as to be at all exposed, and if it did, it would be easy to discern and avoid it. As to the lymphatics, it does not appear that any mischief has ever resulted from the infliction of such injury upon them as may occur in the ordinary operation.

* Hutchinson's Letter on the operation for Popliteal Aneurism.

to the muscles of the abdomen. It ascends so high as to inosculate with some of the twigs of the internal mammary. It also communicates with the epigastric and with its fellow of the opposite side.

Other anomalous and inconstant twigs are given off by the femoral artery in this region, to supply neighbouring muscles and integuments.

The *Superficial Muscular Artery* is next in order. It is designed to supply the muscles on the outer and anterior part of the thigh, and springs from the F. about an inch and a quarter from Poupart's ligament. It

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Mr. Hodgson has advised to make the incision precisely upon the sartorious, and then to expose and retract its border. For this, also, there is no sufficient reason, and it is obvious that it must render the operation less simple. If indeed, the cut be continued along the oblique course of this muscle, it is obvious that its direction must traverse that of the femoral artery at an acute angle, and will be more liable to inflict injury upon those superficial vessels which ascend vertically upon the inner side of that vessel.

But sometimes it may be necessary to secure the femoral artery in the inferior section of its course, where involved in the muscles of the thigh. It will be recollected that in this region Hunter first performed the ligature of the femoral, artery for popliteal aneurism, believing it to be necessary to apply the ligature thus near to the seat of disease. Subsequent experience has, however, shown that it is neither necessary nor safe, for reasons above specified. Wounds of the vessel, nevertheless, may make it necessary to apply the ligature in this region.

When we would seek the vessel where it is approaching the foramen in the triceps and covered by the sartorious muscle, the patient should be placed in the supine posture, and the limb be rotated outward. The course of the saphena vein may be ascertained by pressure made upon that vessel above, causing it to become expanded. The course of the artery is to be ascertained as before, and along this line an incision is then to be made, commencing near the middle of the thigh, the saphena vein being avoided. This incision should be four inches in length, and should at the first stroke of the knife be carried merely through the integuments; next, through the fascia lata, to a nearly equal extent. The sartorius, now exposed, must be strongly retracted outwardly with a flat curved retractor insinuated beneath its inner margin. The strong fascia which immediately invests the artery in this region is now to be freely divided with the aid of the director. The sheath of the vessels is now exposed, in which are involved the saphanus nerve, the femoral artery, and the vein—the nerve on the anterior internal aspect of the artery—the vein behind it. The sheath is then to be divided, the nerve to be retracted inwardly, and the aneurism needle to be insinuated between the artery and vein in the manner already described.

The engraving illustrates the above operation on the left side. The sartorious is seen reflected externally. The artery is seen raised from its bed and giving off the great anastomotic. The vein is covered by the artery. The crural nerve is seen within. The deep fascia is seen covering the upper portion of the artery.

It is manifest that the operation thus performed is infinitely more difficult of execution, and must be more frequently productive of unpleasant consequences than that which is performed upon the vessel in the superior region. The wound is deeper—divides several layers of fascia, and is not direct, consequently there are liable to occur depots of matter and fascial inflammation.

The Profunda Femoris. Sometimes the femoral artery gives origin to the profunda very near to Poupart's ligament. As this vessel is nearly as large as the femoral, and as it is occasionally the seat of aneurism, the ligature has been applied to the femoral artery, near Poupart's ligament, for the relief of aneurism supposed to be located on the lower section of this vessel, when, in fact, the profunda alone was concerned, and when, consequently, the operation has proved altogether ineffectual. When the femoral, near Poupart's ligament, is exposed for the ligature, pressure should always be made upon it before the thread is tied, for the purpose of ascertaining its effects on the aneurism. If the tumour still pulsates and remains undiminished in size, the aneurism is one of the profunda.

So, also, when a ligature is about to be applied for the suppression of traumatic hemorrhage, supposed to be from the femoral or one of its branches, temporary pressure should first be tried, and if it proves ineffectual, the profunda is presumed to be concerned. In such cases it will sometimes be deemed expedient to trace the femoral higher, and to

Drawn on Stone by G. Smith.

G. Mulligs Lith.

insinuates itself between the sartorius and the rectus femoris, imparting twigs to both. It is then resolved into twigs, which curve upward, beneath the tensor vaginæ femoris, being appropriated to it and to the glutæus medius.

The Arteria Profunda Femoris, the muscular artery of the thigh, is next in order. Most frequently this important vessel arises from the posterior aspect of the femoral, at the distance of an inch and three quarters from Poupart's ligament. Sometimes, however, it takes its origin directly beneath that boundary, and sometimes it arises near the border of the sartorius muscle. It immediately pierces the deep aponeurosis, which covers the psoas and pectinæus muscles, and bends a little toward the bone involved in the loose tissue of this region. It then winds inward to the inner side of the femoral. Its general direction is obliquely backward, as far as the origin of the middle portion of the triceps extensor muscle. It then inclines inward, descending along the inner side of the femur, and upon the anterior face of the adductor muscles, to the middle of the thigh. That which is regarded as the continued trunk, then pierces the aponeurosis of the adductor muscle, and, having reached the posterior region of the thigh, is resolved into two branches, one of which is appropriated to the short head of the biceps, and the other to the semi-membranosus.

In the course which it thus pursues, the profunda gives origin to five considerable branches—the external circumflex, the internal circumflex, and the three perforating branches.

1. The *External Circumflex*, (Circumflexa Externa,) springs from the outer side of the P. where it presents its convexity outwards, as it bends inward, near its origin. In size it sometimes equals the remainder of the trunk from which it arises. It passes abruptly outward, behind the rectus femoris, and there it is not unfrequently resolved into two branches. One of these, the *ascending*, winds round the outer and upper part of the os femoris, and is resolved into twigs, some of which reach the capsule of the hip joint, while others are appropriated to the muscles which the artery traverses in its course—the deep portion of the triceps, the deep glutæi, the tensor vaginæ and the rectus. The *descending* branch passes vertically downward, beneath the rectus femoris, and is resolved into numerous branches, some of which even reach the vicinity of the knee joint and inosculate with the articular arteries.

2. The *Internal Circumflex*, (C. Interna,) is the vessel appropriated to the voluminous muscles on the inner and upper part of the thigh. It is the larger of the circumflex arteries, and arises from the very root of the profunda, at its back part. It passes very abruptly backward, between the pectinæus and the tendon of the psoas. It winds round the inner part of the neck of the femur, skirts the border of the obturator externus muscle, and insinuates itself beneath the adductors, brevis and magnus. In its course it gives twigs to all the above named muscles, and to the inner portion of the apparatus of the hip joint. One of its branches, ascending on the neck of the femur, passes upon the surface of the quadratus femoris muscle into the fossa on the inside of the great trochanter, where it is resolved into branches, appropriated to the muscles there inserted. Another branch passes outward, between the quadratus femoris and the femur, and gains a situation behind the upper extremity of the bone, where it is appropriated to the flexores cruris muscles, which arise from the tuber of the ischium.

Index to Plate XV. Number 1 marks the Sacrum; 2, Glutæus Medius m.; 3, G. Maximus; 4, Pyriformis; 5, Glutæus Medius; 6, insertion of the G. Medius and Min.; 7, posterior Sacro-Sciatic Ligament; 8, Sciatic Nerve; 9, great Trochanter; 10, the Quadratus Femoris m. above which the Gemelli are seen; 11, long head of the Biceps m.; 12, Semi-tendinosus m.; 13, portion of the Adductor; 14, Gracilis; 15, Semi-membranosus; 16, Adductor Brevis; 17, Cruræus; 18, Vastus Externus; 19, Adductor magnus; 20, Section of the long head of the Biceps—short head above; 21, Patella; 22, internal head of the Solæus; 23, internal head of the Gastrocnemius Externus; 24, external head of the same.

25, Gluteal Artery; 26, Ischiatic A.; 27, branch of same given to the joint; 28, descending branch, or continued trunk of the same; * superior and inferior branches of the Pudic; 29, the superior Perforating branch of the Profunda; 30, same continued; 31, inferior Perforating; 32, Popliteal; 33, Anastomotic; 34, 35, Superior Articular; 36, Internal Articular; 37, Sural Artery; 38, 39, Inferior Articular; 40, Sural.

3. The *Superior Perforating Artery* is the next in order. It arises from the perforating below the lesser trochanter. It directs itself backward, and pierces the tendon of the adductors, giving twigs to it. Having gained the posterior region of the thigh, it is resolved into two branches; one of which ascends as high as the glutæus maximus; while the other is given to the long head of the biceps, the outer portion of the triceps, the semi-membranosus, and the sciatic nerve. It anastomoses with the internal circumflex, the ischiatic and the middle perforating.

4. The *Superior Perforating* is the next in order and in magnitude. It pierces the broad tendon of the adductor muscles, and in the posterior region of the thigh is resolved into branches, some of which are reflected upward. They ascend as high as the great trochanter and the margin of the glutæus maximus

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secure it upon the origin of the P. the apprehension that the ligature of the vessel thus high will prevent the establishment of the collateral circulation being discovered to be without foundation. But where it is clearly ascertained that the profunda is the injured vessel, undoubtedly this alone should be secured with as little disturbance to the femoral as possible.

The operation of securing the trunk of the profunda I found it necessary to perform a few weeks since. The necessity demanding an operation, arose from traumatic hemorrhage of one of the perforating arteries. The wound of the vessel was deep among the muscles of the thigh, where it was completely inaccessible; consequently it could not be known whether the bleeding occurred from a branch of the femoral, or from one of the profunda. As the patient was exceedingly exhausted by loss of blood, the bleeding having occurred in the night and profusely, before the fact was observed, I resolved to cut at once for the femoral.

I accordingly cut for that vessel near Poupart's ligament—exposed it within half an inch of the ligament, and cast the ligature around it. Before tying the thread, however, I compressed the vessel, but observed with surprise that the bleeding was not commanded;—indeed, I could still feel with my finger, deep in the wound, the pulsation of the bleeding vessel. On applying my finger to the femoral artery I then discovered the pulsation of a collateral trunk, and found that the profunda arose from the F. close to Poupart's ligament. It descended in close contact with the outer surface of the latter vessel, and was approached with great facility. On compressing it, the hemorrhage ceased and the ligature was immediately drawn upon it. The patient, however, was too much exhausted to recover.

The profunda, near its origin, may be at all times exposed with facility by the same incision with which we approach the femoral in this region. The deepest part of the incision along the line of the artery should be about an inch and a half below Poupart's ligament. The sheath of the femoral being there exposed, the finger of the operator should explore its external side for the pulsation of profunda. It there arises from the posterior aspect of the F. and issues obliquely outward from beneath it, being enveloped by a sheath which is prolonged from the femoral sheath. The latter it is not necessary to open, but the former should be cautiously incised at the distance of half an inch from the femoral artery. The point at which the ligature should be applied must be determined by the locality of the external and internal circumflex arteries. The thread should be drawn as closely above the origin of the superior of these as possible; in order that it may be as remote as possible from the femoral artery.

Aneurisms of the profunda may make it necessary thus to apply the ligature. Traumatic hemorrhage from deep wounds of the thigh will most frequently be found to arise from branches of the P. When, therefore, the individual vessel injured cannot be approached, the ligature must be applied to the trunk of the P. as in the above case.

Circumflex Iliac and Perforating Arteries. The surgical importance of these branches does not correspond to their magnitude. They are so deeply buried and so variable in their relations that they are never sought by the surgeon unless by dilating a wound which has reached them.

When the amputation of the thigh has been performed above its middle it is usually necessary to secure the femoral artery, the profunda, branches of the two circumflex, and sometimes, in the posterior region, inosculating branches of the ischiatic. Lower in the thigh, the surgeon has to secure the femoral, the perforating branches of the profunda, and sometimes the anastomotic.

In case of ligature of the femoral artery, the collateral circulation is established through the anastomoses of the circumflex with the ischiatic, obturator, &c. or those of the circumflex with the perforating branches.

Fig. 1.

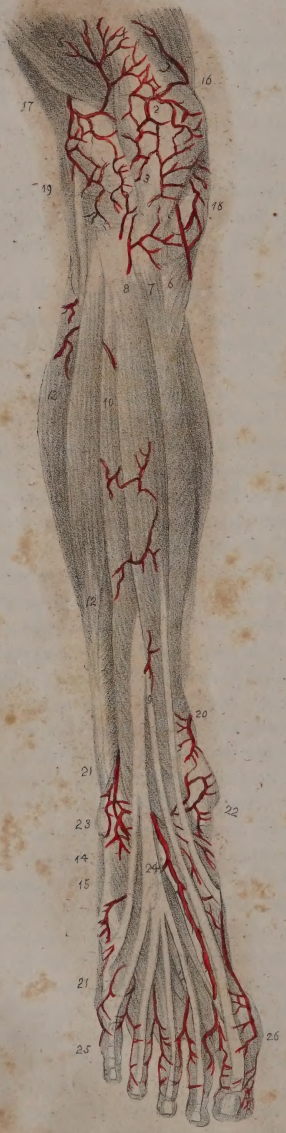

Fig. 2.

Drawn on Stone by S. Finch.

G. Willis's Lith.

muscle, anastomosing with twigs of the last described. Other branches descend, and are appropriated to the biceps, the other flexor muscles of the leg, and to the sciatic nerve. One of the terminal twigs of this artery enters the oblique foramen, which is seen in the linea aspera of the femur, and becomes the nutrient artery of that bone. Others anastomose with the twigs of

5. *The Third, or Inferior Perforating.* This is one of the terminal branches of the profunda. It takes its origin from the profunda, low in the thigh, and pierces the tendon of the adductor near where its parent trunk passes that boundary. It is distributed to the muscles of the posterior region of the thigh, inosculating above with the branches of the last described, and below, with the superior articular arteries.

The next branch of importance which arise from the femoral is the

Anastomotic Artery, (Anastomotica Magna.) This vessel springs from the femoral, very near where this trunk is engaging itself in the tendon of the adductor. It issues from beneath the fascia which covers the femoral, in the middle third of the thigh, and descends to the inner side of the knee joint. It divides into three or four branches as it approaches the condyle, some of which are appropriated to the vastus internus and cruræus muscles. The branch which is regarded as the continuation of the artery descends on the inside of the knee, together with the saphenus nerve. There it inosculates freely with the internal articular arteries, and gives twigs to the integuments and to the apparatus of the joint. This vessel is often absent. Sometimes it is very large. Its inosculations are concerned in the establishment of the collateral circulation, when the popliteal is obliterated.

The Popliteal Artery. As soon as the femoral artery has issued from the oblique canal of the adductor tendon, it assumes new relations and an appropriate name. Its general course from this point is obliquely downward and outward, to the lower border of the popliteus muscle, where it is resolved into the anterior and posterior tibial arteries.

The point at which the femoral becomes the popliteal artery is five inches vertically from the internal condyle of the femur. The direction of the vessel is a little obliquely outward, as it descends;—it being near the inner ham-string at its superior extremity, but, at the lower, nearer to the outer border of the leg than to the inner.

Anteriorly, the popliteal artery at its upper part, has the tendon of the adductor magnus in front of it. A little lower it has the femur in the same relation, being separated from it only by adipose tissue. Still lower, it has in front of it the posterior ligament of Winslow, which bounds the apparatus of the joint behind.

Index to Plate XVI. Fig. 1.—No. 1 marks the tendon of the Quadriceps Extensor; 2, the Patella; 3, the Ligament of the Patella; 4, the Vastus Internus muscle; 5, the Vastus Internus; 6, insertion of the Sartorius and Gracilis; 7, Tubercle of the Tibia; 8, Tibialis Anticus m.; 9, Extensor Proprius Pollicis P.; 10, Extensor Communis Digitorum; 11, Peroneus Tertius; 12, Peroneus Longus; 13, Gastrocnemius Externus; 14, Tendon of the Peroneus Longus; 15, Extensor Brevis Digitorum; 16, 17, Superior Articular Arteries; 18, 19, Inferior Articular A.; 20, inosculating branch of Posterior Tibial; 21, Anterior Interosseal; 22, Internal M.; 23, External Malleolar Artery; 24, Tarsal Artery, arising from the Dorsalis Pedis which is seen running along the external border of the tendon of the Extensor Proprius; 25, Metatarsal; 26, continuation of the Dorsalis; 27, branch, not always present, given by the last of the three rami; 28, 28, 28, of the Metacarpal to the external border of the lesser toe.

Fig. 2.—No. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, as in the last Fig.; 11, Peroneus Longus; 12, 13, Gastrocnemius Externus; 14, Tendon of the Extensor Proprius; 15, Internal Malleolus; 16, External Malleolus; 17, Tendon of the Peroneus L.; 18, Tendon of the Peroneus Tertius; 19, 20, Superior Articular A.; 21, 22, Inferior do.; 23, Anterior Tibial Artery; 24, Recurrent Tibial; 25, muscular branch inosculating with the Articular and Anastomotic; 26, muscular of Tibial; 27, Anterior branch of Peroneal; 28, inosculating branch of T.; 29, External Malleolar; 30, Dorsalis Pedis giving off the Internal Malleolar; 31, Branch to the inner margin of the foot; 32, Tarsal and Metatarsal, having common origin; 33, Dorsalis; 34, 35, Digital Arteries of the foot, having their origins a little different from the ordinary arrangement; 36, Dorsalis Pedis dipping between the metatarsal bones to join the Plantar Arch.

The artery there lies partially lodged between the projecting condyles of the femur. Below the joint it has the popliteus muscle before it, a small quantity of adipose tissue intervening.

Posteriorly, the popliteal artery has the popliteal vein closely adherent to it, inclining to the outside of it as it descends. Still further behind, and to the outside of it, is situated the popliteal nerve. All these organs are then enveloped posteriorly in a considerable mass of adipose tissue, involving small glands and twigs of vessels, covered by the aponeurosis of this region, and lastly by the common integuments.

Internally, the P. A. at its superior part, runs close beside the semi-membranosus, diverging from it as it descends. Still lower, and in the notch of the condyles, it has the inner condyle and the inner head of the gemellus on its internal aspect.

Externally, it has, first, the tendon of the biceps almost in contact with it, and, lower, the external condyle and the external origin of the gemellus.

The branches which spring from the popliteal artery, in the vicinity of the joint, are five in number. They are designed to supply the joint, its appendages, the muscles of its vicinity, and the parts which envelope it. To accomplish this, these small branches are usually furnished;—two to the upper region of the joint, two to the lower, and one to the middle.

1. The *Internal Superior Articular Artery*. This vessel is of considerable magnitude. It is exceedingly variable in regard to its point of origin; and, indeed, there are very frequently two or three, arising independently, which supply its place. It may spring from any point of the P. A. between the condyles. From its place of origin it usually passes downward and inward, under the tendon of the adductor magnus, winding around the root of the inner condyle and giving twigs to the periosteum. Having reached the inner and anterior aspect of the bone, it is resolved into two branches. One of these descends, creeping upon the surface of the bone and beneath the triceps muscle, and is appropriated to contiguous parts, inosculating freely with the external superior articular artery. The other branch follows the tendon of the adductor magnus to the inner part of the condyle, and is there resolved into numerous twigs, which are given to the inner part of the joint, inosculating with the anastomatic artery.

SURGICAL OBSERVATIONS.

The Popliteal Artery. This vessel although not often approached by the knife is exceedingly interesting to the surgeon as being, more frequently than any other artery of its class, the seat of aneurism. Richerand and other surgeons believe that the very free flexions and extensions which occur at the articulation of the knee, by alternately doubling, and forcibly extending, the popliteal artery, inflict upon its tunics injury which gives rise to aneurism. When we consider that the artery is closely bound above to the adductor tendon, and below to the tendons of the gastrocnemii; also that the condyles become protuberant behind, when the leg is perfectly extended, and that the vessel is strained over them, it appears manifest that when the coats of the artery have become rigid from age or disease, a sudden and forcible extension may inflict that injury upon the tunics which may give rise to aneurism, even although, as Scarpa observes, there are no instances of complete laceration of the vessel thus produced. It would be impeaching the economy of nature, however, to suppose that any accustomed motion could inflict injury upon a healthy vessel.

Aneurism of the P. A. is readily distinguished by the general traits of the disease. The peculiar relations of the vessel, however, give rise to peculiar phenomena. When aneurism occurs on the lower portion of the vessel, the tumour will be so confined below in the angle of the gastrocnemii as to be forced upward into the middle of the ham. So, when it occurs on the superior portion near the perforation in the adductor, it will, by the approximation of the muscles of the ham, be forced downward into the same region. The summit of the tumour then, in all cases, will occupy nearly the same situation. Its point of origin may be ascertained by the history of the case.

The expansion of the tumour being resisted laterally by the ham-strings, and posteriorly by the strong fascia of the ham, the aneurism throbs with great force upon the posterior surface of the femur, sometimes causing caries and destruction of the bone. The leg can never be perfectly extended, or completely flexed, and if, when partially flexed, it is thrown over the other limb, so that the diseased ham shall rest upon the opposite knee, very obvious motion is communicated to the leg by each pulsation of the tumour.

2. The *External Superior Articular Artery.* This vessel arises from the P. above the outer condyle of the femur. It insinuates itself beneath the biceps flexor, and winds round the femur to its anterior and external aspect. Like the former, it is resolved into two branches, of which the superior ramifies in the triceps muscle, while the inferior, or internal, descends obliquely on the condyle, under the involucre of the joint, to the patella, on which it inosculates with the internal superior articular artery.

3. The *Middle Superior Articular Artery.* This is a small twig, but pretty uniformly present. Its course is almost directly forward. It pierces the ligament of Winslow, and is then divided into two branches, of which one descends behind the crucial ligaments and loses itself in the neighbouring cellular tissue. The other passes deeply into the fossa which separates the condyles, and thus approaching the centre of the articulation, is appropriated to all the apparatus of the joint—the crucial ligaments, the synovial membrane, the fatty substance, &c.

4. The *Internal Inferior Articular Artery.* This vessel arises from the P. above the poplitæus muscle, and is appropriated to the head of the tibia and adjacent soft parts. It creeps inward, beneath the sciatic nerve and the inner head of the gastrocnemius muscle. It attaches itself closely to the periosteum which covers the head of the tibia, and winds round that bone beneath the internal lateral ligament and the tendons of the sartorious, gracilis, and semi-tendinosus. It then bends upward and ascends along the inner edge of the patella as far as its lower edge, where it anastomoses with the superior articular, and the external inferior articular. In its course it sends twigs to the gastrocnemius internus and poplitæus muscles.

5. The *External Inferior Articular Artery* arises from the P. still lower, beneath the external condyle. Its origin is concealed by the origin of the plantaris muscle, where it arises from the external condyle. It passes obliquely outward and downward, above the soleus muscle, and between the poplitæus and gastrocnemius. It then insinuates itself beneath the tendon of the biceps flexor cruris—also, beneath the external lateral ligament of the knee-joint. It gives branches to all these parts beneath which it passes. It then passes obliquely over the edge of the semilunar cartilage, and advances transversely as far as the lower part

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POPLITEAL ARTERY.

It must be obvious that, to cut for the popliteal artery, deeply buried as it is between the condyles, beneath the popliteal nerve and vein, absorbent glands, fatty substance and the firm fascia, must be a matter of no small difficulty. Fortunately, it is very rarely necessary, unless some traumatic lesion has been inflicted upon this vessel, or one of its large branches, rendering it expedient to secure it at the point of injury, or as near it as possible

This vessel may be secured either in the upper portion of its course, or immediately behind the knee. The former is accomplished with comparative facility. The patient is to be placed on his face and the leg to be extended. An incision is then to be drawn along the outer border of the semitendonosus, to the extent of three inches. The fascia is next to be divided and retracted externally, and the vessel to be cautiously approached through the abundant fatty substance. To facilitate this, the tendon of the semitendonosus may be drawn inward. The popliteal nerve lies too far without to be exposed, but the vein is found near to the posterior and external aspect of the artery, and should be carefully withdrawn. The pulsation of the artery will now be distinctly felt and is to be secured by passing the ligature from without inward.

In the lower section of its course, the depth and close confinement of the artery between the condyles, render its exposure extremely difficult. The parts which cover and surround it, are rendered tense and difficult of retraction by the necessary extension of the leg. The operation is accomplished by making a vertical incision through the centre of the space between the condyles, the centre of the incision being opposite to the portion of the artery which is sought. The fascia and cellular tissue being divided, the posterior saphena vein, which is here entering the ham, will be exposed and is to be retracted Some of the muscular branches of the artery will probably be cut, and must be secured. The artery, together with the vein and tibial nerve, will now be brought into view between the origins of the gastrocnemii. The leg being then very slightly flexed to relax the muscles, these are as far as possible withdrawn by an assistant; the vein is to be retracted outwardly and the nerve in the opposite direction; and then the aneurism needle may be passed from without, inwards.

of the patella. It is then resolved into two principal branches—a *deep* and a *superficial*. The former first sends a few twigs down upon the tibia to anastomose with the recurrent twig of the anterior tibial; then it plunges beneath the ligament of the patella, and is given to the fatty substance which lies between it and the tibia, sending one branch upward on the tibia to inosculate with the external sup. art.

The numerous vessels, which the popliteal A. thus furnishes to the joint and its appendages, ramify and inosculate, in a very beautiful and complex manner, over the whole surface of the articulation; the arterial net-work thus formed being incorporated with the periosteum of the articulating bones. This free communication with each other, and their inosculation with the anastomotic and recurrent twigs, assists the collateral circulation when the popliteal becomes obstructed or obliterated.

In the lower part of the ham the P. also gives a few irregular twigs, termed *surales*, to the heads of the gastrocnemii muscles.

After having given origin to the last of the articular branches, the popliteal, descending behind the poplitæus muscle, furnishes several branches to the gastrocnemii muscles. At length it reaches the inferior border of the poplitæus muscle, and there terminates in the anterior tibial and the posterior tibial, of which the latter is the larger and the continued trunk.

The Anterior Tibial Artery, (Tibialis Antica.) This important vessel, from its point of origin, passes almost horizontally forward, to be appropriated to the muscles on the anterior part of the leg. Before it gains that situation, however, it gives twigs to the flexor longus digitorum and to the tibialis posticus. It then pierces the head of this muscle and the interosseous ligament, and, bending downward, is deeply lodged between the tibialis anticus, and the peroneus longus. Descending vertically, it is next lodged between the tib. anticus and the long extensor of the toes;—finally, between the former m. and the extensor of the great toe, and, dipping under the annular ligament of the tarsus, becomes the dorsalis pedis.

SURGICAL OBSERVATIONS.

The popliteal artery may be effectually compressed by a convex pad thrust between the ham-strings, pressing the artery upon the bone; in this, however, there is often so much pain that it cannot long be endured; of which, one may easily form an idea, by pressing the finger firmly into this region for a moment.

The branches of the popliteal artery are but little concerned in surgical operations. Obstinate traumatic hemorrhage sometimes arises from wounds inflicted upon the head of the tibia, owing to the articular arteries being bound by the periosteum so closely to the bone that they are not capable of retraction. It is difficult to elevate the bleeding vessel with the tenaculum sufficiently to apply the ligature; the graduated compress must therefore be resorted to.

The *Anterior Tibial Artery*. It has been remarked by Mr. Ribes*, that the angular bend which the A. T. makes after passing the interosseous ligament, to descend on the leg, accounts for the remarkable retraction of the A. T. after amputation.

The A. T. because of the close manner by which it is embraced by muscles, is very rarely the seat of aneurism. Nor is it much exposed to wounds, lying as it does deeply buried in the narrow space between the bones of the leg, and covered by voluminous muscles. Sometimes, however; it is reached by penetrating wounds which render the ligature necessary, as in one instance occurred to myself.

To expose this vessel with precision we must first determine the line of its course. This is done by stretching a thread from the anterior part of the head of the fibula to the interstice between the first and second toes. This thread will fall on the outer border of the tibialis anticus muscle, and will indicate the course of the vessel lying, above, between the muscles and the communis extensor—below, between it and the proprius pollicis. Another mode is to draw a vertical line midway between the spine of the tibia and the fibula;—a third, to draw this line an inch and a quarter from the margin of the tibia. This last, however, is very fallible, because the interstice, which, above, is nearly an inch and a quarter from the spine, is not more than half an inch from it at the lower extremity of the bone. The distance is also various in limbs of different dimensions. Another method is to feel carefully for the interstice, with the finger, the foot

* Velpeau's Surgical Anatomy, v. ii. p. 424.

In the upper region of the leg the T. A. lies deeply buried between the tibia and fibula. It is there lodged on the interosseous ligament. As it descends, it still rests on the ligament, but becomes much more superficial, because the muscles which embrace it diminish in diameter, terminating below in tendons. In the upper third of its course, it is from one and a half to two inches remote from the anterior surface of the limb. In the middle of the leg it is ordinarily an inch and a quarter deep; but in the lower third of its course, its depth is but three-fourths or half an inch. On the inside it is bounded, through its whole course, by the tibialis anticus muscle and tendon. Consequently as that muscle tapers from above, the artery is constantly approaching the tibia.

On the outside, the artery is bounded, first, for a short distance, by the peroneus longus; then, in the lower part of the upper third of the leg, by the common extensor of the toes; and, lastly, during the remainder of its course, by the proper extensor of the great toe.

Anteriorly the artery is first covered by an aponeurotic membrane, which closely binds it down. Next the muscles, above described, collapse over it—the external border of the tibialis anticus being every where anterior to it. These muscles are then enveloped by the strong aponeurotic fascia of the leg. On the ankle it is invested anteriorly by the ligament of the tarsus.

The artery is accompanied by two venæ comites, and by a nerve. The former are situated one upon each side of it, and the nerve descends in front.

After passing the interosseous ligament, the ant. tibial A. immediately gives origin to the *tibial recurrent*, which pierces the tibialis anticus muscle, and passes obliquely upward and inward toward the knee, traversing the tibial aponeurosis, and being resolved into many twigs which anastomose around the knee joint with the inferior articular arteries.

In its descent along the leg, the anterior tibial gives origin to numerous branches which supply the periosteum of the tibia and the numerous muscles which are lodged between that bone and the fibula—the tibialis anticus, the extensor of the pollex pedis—the extensor of the toes, the peroneus, &c. Some of

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being flexed. The tense fascia, it is true, renders it obscure, but the finger more easily indents the parts along the line of the interstice. In determining the line of the incision, "to make assurance doubly sure," it is well to practice all these methods.

But a rule which I have myself practised is, I believe, as little fallible as any other. Encircle the leg with a piece of tape, and thus get its circumference; divide this into eight parts and you have the distance of the artery from the spine of the tibia, at the part where the circumference is taken; for the vessel, all along the leg, is distant one-eighth of its circumference from the spine of the tibia.

Lisfranc deems it so difficult to strike this interstice, that he advises to cross it with the knife by an oblique external incision from the spine of the tibia to the fibula; but this is justly condemned as rendering the subsequent steps of the operation more difficult.

To reach the vessel, the incision should be made along the interstice of the muscles to the extent of an inch and a half, or two inches and a half, according to the distance from the ankle, the artery being, as above described, much deeper above than below. The fascia is next to be incised to nearly the same extent, and the finger gently insinuated between the muscles. The artery will be found, in the upper part of the leg, deeply lodged between the tibialis anticus and the extensor communis; below, between the former and the extensor proprius, dipping under the tendon of the latter as it approaches the annular ligament. Together with the nerve and veins it is enveloped in a cellular fascia which also binds it to the muscles. This must be cautiously divided, the nerve, the general position of which is in front of the artery, is a little on the inner aspect above, and on the outer below; the veins are on either side. The extreme difficulty which occurs in the application of the ligature in this operation, arises from the closeness with which the muscles are bound down by their extensive attachments and by the fascia of the leg, and their being deeply lodged between the bones of the leg; in consequence of which the muscles cannot be retracted to expose the vessel. Nor can the vessel be withdrawn from its deep situation, because of its straightness and its close attachment to the interosseous liga-

these twigs anastomose internally with those of the posterior tibial—externally with those of the peroneal. Ramuli also pierce the interosseous ligament, to supply, partially, the deep muscles of the posterior part of the leg.

As it approaches the ankle the T. A. gives origin to two considerable branches, the internal malleolar—the external malleolar.

The *internal malleolar* passes off abruptly from its trunk and dips transversely under the tendon of the tibialis anticus, and having thus reached the inner malleolus, it descends upon the inner side of the ankle joint, and is resolved into numerous twigs which communicate with those of the posterior tibial.

The external malleolar insinuates itself behind the proper and common extensors of the toes and the peroneus tertius, and descends upon the outer malleolus. It is then resolved into numerous ramuli, which overspread the inner surface of the joint and descends upon the tarsus. It inosculates with the posterior tibial and with the dorsal and plantar arteries of the foot.

The Dorsal Artery of the Foot, (Arteria Dorsalis Pedis.) This vessel is the direct continuation of the A. T. It extends from the annular ligament of the ankle to the interstice of the two inner metatarsal bones, and is destined to supply the dorsum of the foot, the dorsa of the toes, and to aid in supplying the sole of the foot. The direction of this vessel is a little obliquely inward, decussating, at a very acute angle, the tendon of the extensor proprius, beneath which it passes, near the annular ligament. In the first part of its course this vessel has the tendon of the extensor proprius above—lower, the external margin of the extensor brevis overlaps it. At the middle of the dorsum of the foot it is crossed obliquely by the inner tendon of the extensor communis brevis. At other points the vessel is covered merely by an aponeurotic fascia, and by the common integuments. The dorsal artery, in the above course, gives origin to several interesting branches.

The Tarsal Artery—springs from the D. on the os naviculare, and passes obliquely outward and forward, beneath the extensor brevis muscle, decussating its fasciculi, to the outer border of the foot, where

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SURGICAL OBSERVATIONS.

ment. In applying the thread, the foot should be flexed in order to relax the flexor muscles as much as possible. Great care should be taken that the nerve or one of the veins be not mistaken for the artery. For the application of the thread, the best instrument is the needle of Dessault, already mentioned, (page 46.)

I once had occasion to cut for, and secure, this vessel on the leg of a very muscular man, in a case of wound of the artery by a narrow chissel thrust obliquely among the muscles of the leg. I found the operation to be far more difficult than the ligature of any vessel which I have ever secured. This arose in part, however, from the imperfection of the instrument employed, which was a common aneurism needle abruptly bent near the point.

If the surgeon would cut for the A. T. where it traverses the ankle, his incision should be made vertically in the middle of the anterior intermalleolar region, along the outer border of the tendon of the extensor proprius. The integuments will be first divided, then the annular ligament—lastly a quantity of very firm cellulo-adipose tissue, when the sheath of the vessel will be exposed. But as this operation is productive of mischief to the tendons of this region, and is comparatively difficult of accomplishment, it ought never to be attempted but when the artery has already been wounded in this region.

The Dorsal Artery of the Foot. This vessel is comparatively much exposed to injury, and often requires the ligature, either on account of its own wounds, or those of its branches. Its course may be indicated by a thread drawn from the centre of the intermalleolar space toward the interstice of the two first toes. An incision along this line will fall between the tendon of the extensor proprius, and that of the extensor communis. It will first divide the integuments and superficial fascia—then the membrane which unites the two tendons—lastly, the deep aponeurosis which binds down the vessel. The margin of the extensor brevis must be slightly everted. The nerve of the dorsum, which lies between it and the tendon of the extensor proprius, is to be avoided.

On the tarsus, this vessel is conveniently situated for effectual compression in case of hemorrhage from one of its branches not easily approached with the ligature. A small compress firmly bound upon the tarsal bones, in the course of the artery, will arrest its pulsations.

it dips beneath the tendon of the peroneus longus. It gives twigs to the ligament of the tarsus—to the periosteum of the bones—to the extensor brevis, and inosculates, on the outer border of the foot, with the plantar artery.

The *Metatarsal Artery* arises from the D. in the first interosseous space, near the middle of the dorsum of the foot. It passes outward and forward beneath the tendons of the extensor brevis, and obliquely across the metatarsal bones, arching on the top of the foot, so as to present its convexity toward the toes. From its concavity it imparts twigs to the slips of the extensor brevis—from its convexity it gives origin to three considerable twigs termed dorsal interosseous arteries of the foot. They occupy the second, third and fourth interosseous spaces, and pass forward to the extremities of the metatarsal bones, communicating with perforating twigs of the external plantar. They rest on the dorsal interosseal muscles, to which they give twigs, as well as to the bones and integuments. At the first joints of the toes they communicate with the anterior perforating arteries, and are there resolved each into two branches, which follow the corresponding margins of the toes from the outer margin of the second to the inner margin of the last.

Immediately before dipping into the interosseous space, the D. gives origin to a considerable twig, which runs along the outer aspect of the metatarsal bone of the great toe, to the first joint of that member, and is there resolved into two branches—one corresponding to the outer margin of the great toe—the other to that of the second.

When the dorsal artery has at length reached the sole of the foot, by penetrating between the heads of the metatarsal bones, it is reflected outwardly, between the accessory muscles of the flexor longus digitorum and interossei muscles, and is resolved into two branches. The external of these still passes outward, and, anastomosing with the external plantar, assists to form the plantar arch. The other branch passes forward between the metatarsal bones, and is lodged in the interstice, between the abductor pollicis and flexor brevis pollicis muscles. After having given twigs to these organs, it furnishes one which winds to the inner side of the great toe, and arrives at its extremity. The branch then pierces the flexor brevis muscle, and is resolved into two twigs, which pursue the corresponding edges of the two first toes.

The Posterior Tibial Artery, (Arteria Tibialis Postica.) This, the continued trunk of the popliteal, commences at the inferior border of the popliteus muscle, where the anterior tibial is given off, deeply lodged between and behind the heads of the gastrocnemii. It is slightly flexuous, and, at first, bends a little inward, beneath the inner head of the gastrocnemius internus. It then descends vertically behind the tibia, and between the two layers of deep and superficial muscles, to the groove behind the internal malleolus,

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POSTERIOR TIBIAL.

When the anterior tibial is wounded in the ankle, and it is deemed advisable to secure the artery above the wound, if bleeding should recur from the lower orifice, it may be arrested by compression made on the dorsalis.

Posterior Tibia. This vessel is rarely the seat of aneurism. Nor is its trunk much exposed to traumatic injury; its branches, however, on the ankle and in the sole of the foot, are much exposed to lesion, particularly the latter.

If we would cut for the P. T. in the superior third of its course, its relations above described being carefully called to mind, the leg flexed upon the thigh and the foot gently extended, a vertical incision should be made three inches in length, and half an inch behind the inner and posterior angle of the tibia. First, it is to be carried through the skin and subcutaneous tissue, the saphenus nerve and vein, sometimes in this situation, being avoided. Next, the crural fascia must be incised where it covers the interstice between the internal portions of the gastrocnemius externus and internus. The flesh mass of the latter muscle is then exposed, arising from the border of the tibia, and is to be divided down to the aponeurosis which forms the posterior face of this muscle. An important step of the operation is then to divide this sheet with the aid of a director, to the extent of two inches or more, at the distance of half an inch from the inner border of the tibia. The artery will then be found lying on the deep muscles and bound down to them by the cellular fascia which wraps them. This membrane is then to be cautiously divided and the artery is found lying between its venæ comites. The posterior tibial nerve, which is behind it, must be avoided, and the needle passed from within externally.

where it is resolved into the two plantar arteries. A line drawn from the middle of the upper part of the calf, to the posterior part of the inner malleolus, will nearly indicate its general course.

The tibialis postica, for the extent of an inch and a quarter, is lodged upon the posterior face of the interosseous ligament—bounded posteriorly by the interstice of the gastrocnemii muscles. It is there accompanied by venæ comites, and by the posterior tibial nerve, which is obliquely behind and upon the inner side of it. At the termination of this portion of its course the P. T. gives origin to the peroneal, by far its largest branch, and which we shall describe separately.

Below this point the P. T. in the upper and middle thirds of the leg, is covered posteriorly by a fascia which wraps the deep muscles on which the artery rests—by the gastrocnemii muscles—by the fascia of the leg, and the integuments. In the lower third of its course, the vessel is covered posteriorly only by the fascia of the leg and the deep fascia, running nearly parallel with the border of the tendo Achillis.

SURGICAL OBSERVATIONS.

The accompanying cut illustrates the mode of cutting for the posterior tibial as just described, on the left extremity. The fascia or sheath which embraces the artery, nerve and veins is seen opened. The artery is raised from between its two veins. The nerve is seen within. The incision in the gastrocnemius internus is seen, and internally the border of the externus. Upward and outward is seen the saphena vein.

An error, sometimes committed in this operation, consists in making the incision too close to the posterior surface of the tibia, by which the tibialis posticus muscle is raised, and the operator gropes among the muscles behind the artery. In another instance, forgetting that the artery is bound down by a deep fascia, he urges his finger beyond it into the interstice between the soleus and the deep muscles. Both of these sources of embarrassment may be avoided by carefully observing the above directions.

It is necessary that, in executing this operation, the surgeon should be provided with flat curved retractors, as the retraction of the muscles which envelope the artery, is sometimes very difficult, so much so indeed, that, in one instance, M. Boucher, of Lyons, was obliged partially to divide the muscles transversely.*

If we would secure this vessel at the middle of the leg, the same incision should be made, but a little nearer to the angle of the tibia. There being no portions of the soleus to divide, the operator elevates the border of that muscle and directs his incision a little obliquely backward from the face of the tibia, to avoid raising the tibialis posticus. He then divides the cellular fascia which binds down the artery, about half an inch from the border of the tibia.

The engraving exhibits the incision for the ligature of the posterior tibial, on the left extremity, below the calf of the leg. The artery is seen raised from between its venæ comites. The nerve is seen within, and the border of the tendo Achillis still within it. The incisions in the deep and in the superficial aponeurosis are also seen, and exterior to both a branch of the saphena vein.

When it is sought on the inferior third of the leg, the incision, two inches and a half in length, should be made vertically, midway between the border of the bone and that of the tendo Achilles. The skin and the aponeurosis of the leg are to be divided as before;—then the cellulo-adipose substance filling the space between the tendo and the deep muscles, when the artery will be found resting on the flexor longus digitorum, and lodged between the tibialis posticus and the flexor longus pollicis. It is bound down by the fascia which wraps these muscles and which must be carefully divided. The operator should cautiously avoid entering the cellular sheath which envelopes the tendon, instead of the space between the tendon and muscles.

* Velpeau's Surgical Anatomy.

In the upper third of its course, the P. T. is bounded anteriorly by the tibialis posticus, on which it is sustained;—in the middle third it has the same relation to the flexor digitorum communis;—still lower it is separated from the bone and from the apparatus of the joint merely by cellular tissue.

The point at which the P. T. terminates in the plantar arteries, is situated in the superior and anterior part of the deep fossa, which is behind the malleolus and in the os calcis, between the origins of the adductor pollicis. The artery, in approaching this point, is situated about a quarter of an inch behind the tendons of the tibialis posticus and flexor digitorum communis, a vein being situated on each side of it, and the posterior tibial nerve behind and without. If the finger be pressed into the deepest part of the hollow, between the malleolus and the prominence of the heel, it will cover this artery; it is remote from the malleolus about one-third of the distance from the malleolus to the heel.

The P. T. is accompanied, during its whole course, by its two venæ comites. The posterior tibial nerve, in the upper region of the leg, lies upon its inner side, but, as it descends, crosses it and gains the outer side.

The tibialis postica, as it descends, imparts nameless irregular branches to all the organs which it approaches—the gastrocnemii muscles (very few), the integuments, the tibialis posticus, the flexor of the toes, the periosteum and the tibia. To the latter it gives the nutritious artery. This arises above the middle of the trunk, and descends on the face of the bone in a groove furnished for it, and penetrates the oblique canal, by which it reaches the cancelli of the tibia, where it is indefinitely ramified. Sometimes this branch arises from the P. T. above the peroneal.

When the P. T. has reached the groove in the os calcis, it furnishes twigs to the bone—to the adductor pollicis, the flexor brevis of the toes, and the integuments. Some of these twigs ascend upon the inner margin of the foot and inosculate with those of the anterior tibial.

PLANTAR ARTERY.

It may be desirable, in some instances, to cut for the P. T. where it is turning behind and beneath the malleolus, though the higher operation is preferable, if adequate, because of the complicated relations of the vessel on the inner ankle. To expose it a semilunar incision must be made half an inch behind the border of the malleolus and in the deepest part of the fossa then situated. The incision will first sever the skin, then the subcutaneous cellular tissue which is here very dense and voluminous, next the strong transverse fibres of the aponeurosis of the ankle. The artery will be found with its veins involved in the same sheath with the nerve and the tendon of the flexor pollicis—the nerve being behind—the tendon in front of it. The surgeon must be careful not to approach the malleolus so closely as to open the sheath of the tendon of the flexor.

The cut exhibits the incision for the posterior tibial, on the left extremity, behind the malleolus. The incisions in the superficial and deep aponeurosis are seen. The artery is seen raised from between the venæ comites. The tendon of the flexor pollicis is seen above.

The *Plantar Artery.* This vessel and its branches are sometimes reached by penetrating wounds, and, as its anastomoses with the dorsal artery of the foot are exceedingly free, it is necessary to secure both extremities of the divided vessel. Anatomical precepts have been given for exposing this vessel in the sole of the foot. They appear to me, however, to be quite useless, insomuch as the artery is never sought for there, unless on account of traumatic lesion, and then the wound must be our principal guide. Aid will, however, be derived from a knowledge of the relations of the vessel as given above. The structure of the sole of the foot is so complicated, and the artery so deeply involved in aponeuroses, tendons, muscles, nerves, &c. that an incision into this region would only be warranted by dernier necessity.

After amputation of the foot, the external and internal plantars require the thread;—also branches of the former.

The *Internal Plantar Artery.* At its commencement this vessel is concealed by the internal annular ligament. Its direction is horizontally forward along the internal margin of the foot, to the muscles of which region it is appropriated. It passes beneath the flexor brevis pollicis and is lost in muscular twigs and anastomosing ramuli.

The first branches of this vessel, near its origin, are given to the ankle joint, the adductor pollicis, the flexor brevis and the integuments. Some of these twigs pierce the muscles and reach the inferior surface of the tarsal articulations.

The I. P. next gives twigs to the flexor brevis, the aponeurosis and the skin. Some are wrapped around the margin of the foot and inosculate with twigs of the dorsalis pedis. The vessel is much smaller than the following.

The *External Plantar Artery.* This vessel is the continued trunk of the posterior tibial. From its origin it departs from the course of the I. P. obliquely outward and downward, in the groove of the os calcis, and insinuates itself between the flexor brevis digitorum and the accessory muscles. It then directs itself forward between the flexor brevis and the abductor of the lesser toe; and is then inflected toward the posterior extremity of the fifth metatarsal bone, passing between the abductor pollicis and the interossei muscles, and the posterior extremities of the metatarsal bones. In this part of its course it describes what is termed the *plantar arch*, the convexity of which is toward the toes. It terminates near the head of the metatarsal of the great toe, by an anastomosis with the dorsal artery of the foot, already described.

Near its origin the E. P. gives twigs to neighbouring muscles and integuments—one conspicuous branch descends upon the heel and is given to the origins of the adductor pollicis, and flexor brevis muscles. It gives twigs, indeed, to all the muscles which it approaches as described above.

Its most important branches, however, arise from the *plantar arch;* these consist of superior, posterior, inferior, and anterior twigs.

The superior branches are three in number, and are often termed the *posterior perforating arteries.* They ascend through the interosseous spaces, giving twigs to the interossei muscles and to the bones, and inosculate with twigs of the metatarsal artery.

SURGICAL OBSERVATIONS.

INDEX TO PLATE XVII. Fig. 1, Biceps Flexor; 2, Semi-tendinosus; 3, Tendon of the Sartorius; 4, Semi-membranosus; 5, Femur; 6, Plantaris muscle; 7, 8, Gastrocnemius Externus; 9, Tendo Achillis; 10, 11, Soleus M.; 12, Peroneus Longus; 13, 14, Peroneus Brevis; 15, Peroneus Tertius; 16, Tendons of the Tibialis Posticus and Flexor Communis Digitorum;

17, Popliteal Artery; 18, 19, Superior Articular Arteries; 20, Surales; 21, Posterior Tibial; 22, Branch of Peroneal; 23, Posterior Peroneal; 24, Peroneal continued; 25, Branch of the Posterior Tibial to the Heel; 26, Branch of the Metatarsal.

Fig. II. 1, Heel; 2, Abductor of the Little Toe; 3, Flexor of the Little Toe; 4, 7, Flexor Accessorius; 5, Flexor Longus Profundus; 6, Flexor of the Great Toe; 8, Short Flexor of the Great Toe; 9, Abductor of the Great Toe; 10, 10, 10, Lumbricales Pedis;

12, Branch of the Posterior Tibial to the Heel; 13, Branch of the Peroneal to the Heel; 14, P. Tibial turning into the sole of the foot and branching into, 15, Internal Plantar, and, 16, External Plantar; 17 and 18, muscular branches; 19, muscular twigs; 20, 21, Digital Arteries.

Fig. III. 1, the Femur; 3, Origin of the Plantaris; 2, 4, Origins of the Gastrocnemius Externus; 5, 6, Semi-tendinosus and Semi-membranosus; 7, Ligamentum Posticum of Winslow; 8, Poplitæus muscle; 9, Internal head of the Gastrocnemius Internus; 10, Peroneus Longus; 11, Flexor Pollicis Proprius; 12, Tibialis Posticus; 13, Flexor Communis Digitorum Pedis; 14, Tendon of the Peroneus Longus; 15, Peroneus Brevis; 16, Internal Malleolus; 17, Tendons of the Tibialis Posticus and Flexor Communis; 18, Insertion of the Tendo Achillis; 19, posterior Ligament of the joint; 20, Os Calcis; 21, Internal Malleolus; 22, Popliteal Artery; 23, 24, Superior Articular A.; 25, Internal Articular; 26, 27, Inferior Articular A.; 28, Anterior Tibial; 29, Muscular branch; 30, Posterior Tibial; 31, Peroneal; 32, Muscular and inosculating branch; 33, 34, Posterior Peroneal; 35, Branch to the Heel; 36, Branch of Peroneal to margin of Foot.

Pl. 17.

Fig. 1.

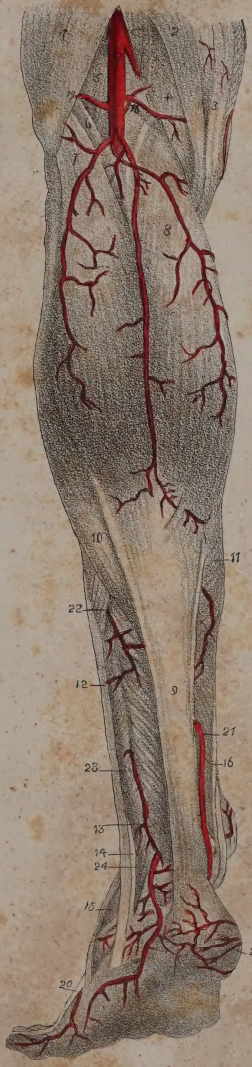

Fig. 2.

Fig. 3.

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C. Willig's Lith.

The posterior and inferior branches are small and quickly lost in the interossei and lumbrical muscles—the cellular tissue and neighbouring articulations.

The anterior branches are conspicuous and usually four in number. The first inclines outward as it advances under the short flexor of the little toe, and is lost on the outer edge of this member, after giving twigs to the muscles just named. The second, third, and fourth correspond to the last three interosseous spaces, giving twigs to the interosseous and lumbrical muscles. As they approach the anterior extremities of the metatarsal bones they ascend above the transversus pedis and send *anterior perforating* twigs to the dorsum of the foot, for inosculation with the metatarsal artery. Between the first joints of the toes the anterior branches are resolved each into two *digital arteries* of considerable size, which correspond to the margins of the toes, from the inner side of the little toe to the outer side of the second, and which are then appropriated precisely as are the digital arteries to the fingers.

The *Peroneal*, or *Fibular Artery*, (Arteria Peronea.) From its point of origin, already described, this vessel descends, inclining a little outward, along the angle of the inner side of the perone, or fibula, to near the malleolus externus. It is lodged between the inner margin of the bone and the flexor proprius pollicis. The tibial nerve is between it and the posterior tibial artery. The P. A. at first rests on the tibialis posticus muscle, but it soon pierces it and then runs anteriorly to it and close to the angle of the bone. Besides the muscle above named it is covered posteriorly by the fascia of the muscle, by the gastrocnemii muscles and tendon, and by the fascia and integuments of the leg.

In its descent this vessel imparts considerable twigs externally and posteriorly to the gastrocnemii muscles and integuments. Internally it furnishes twigs to the tibialis posticus, flexor of the toes, and flexor of the pollex. One of these, situated low in the leg, bends inwards before the flexor muscles and inosculates with the posterior tibial. Near the ankle, the P. A. is resolved into two terminal branches.

1. The posterior fibular artery, pursuing the course of the trunk, descends behind the articulation of the fibula and along the outer side of the os calcis. It gives twigs to the tibialis posticus, flexor of the toes, peronei muscles, the joint, &c. On the heel, it is resolved into twigs which ramify in a complex manner upon, the outer, upper and back part of the foot and are distributed to the short extensor of the toes, the abductor of the little toe, the integuments and surrounding tissue. One branch winds beneath the outer malleolus and inosculates with the anterior tibial.

2. The anterior fibular artery perforates the interosseous ligament and passes under the peroneus tertius. It gives twigs to this muscle and then descends behind the tibio-fibular articulation, and, bending forward and inward, inosculates with the anterior tibial, and, from the anastomotic arch thus formed, twigs are given to all the neighbouring parts.

INTEROSSEAL ARTERY.

The *Interosseal Artery*. This vessel would appear to be almost inaccessible to traumatic injury, and yet there are on record instances in which it has been necessary to secure it. This very difficult operation is accomplished, in the middle of the leg, by drawing an incision along the external margin of the soleus and close to the fibula, to the extent of three inches. The aponeurosis is to be divided, the soleus muscle raised, and then the external border of the flexor pollicis to be dissected from the fibula, when the artery will be found enveloped by that muscle, and lodged between accompanying veins. Unless the operator is deliberate and careful he may grope in the substance of this muscle without finding the vessel. Should it be cut for in the upper third of the leg, it will be unnecessary to wound the muscle, as there the vessel has not yet insinuated itself beneath its fibres. It will be recollected that it was for the ligature of this vessel that Mr. Hey recommended the very unnecessary expedient of excising a portion of the fibula.

The free inosculations which, on the ankle, the interosseal enjoys with the anterior and posterior tibial arteries, may furnish a sufficient supply of blood to preserve the vitality of the foot, even when both the tibials have been obliterated.

Plates 18, 19, and 20, have been, in this edition, in a great degree superseded by the introduction of the wood engravings which illustrate the surgical observations. They are, however, still retained, as necessary to the completion of our design.

INDEX TO PLATE XVIII. Fig. 1. Exhibits a mode of cutting for the Carotid Artery. Number 1 is the Carotid; 2, the Jugular Vein; 3, the Common Sheath, enveloping those vessels, opened so as to expose them; 4, the Omo-hyoid muscle retracted externally; 5, the margin of the Sterno-cleido-mastoid muscle.

In the method here exhibited, (taken from Bierkowski,) the incision is made along the border of sterno-mastoid, directly upon the omo-hyoid as it is emerging from beneath the former muscle. precepts relative to this operation, we have advised that generally the artery should be exposed above the border of the omo-hyoid. The artery is there more superficial, and its exposure requires less displacement of parts. In applying the ligature to the artery in that region, the surgeon is also less annoyed by the spasmodic contraction of muscles.

The artery may, however, be exposed in nearly the same region by contracting the omo-hyoid externally, after having made the usual incision. By so doing, the omo-hyoid, as represented in the plate, is relaxed; whereas by dragging it downward and inward, it is rendered tense. The artery is of course exposed beneath the muscle. To effect this it is obviously necessary to divide the dense fascia which ties the tendon of the omo-hyoid to the lower and anterior part of the neck.

In executing the operation as here represented, we avoid all danger of wounding the branches of the external carotid. I have in my possession a cast of a neck in which the exposure of the carotid above the omo-hyoid would almost certainly have caused a wound of the mastoid artery, which, in this instance, was a branch of the superior thyroid.

Fig. 2. Represents methods of cutting for the Radial and Ulnar Arteries;—the former near the elbow; the latter near the wrist. No. 1 is the Radial Artery; 2, the Supinator-Radii-Longus Muscle; 3, the Pronator-Radii-Teres; 4, the Flexor-Carpi-Radiatis, 5, 6, 7, 8, superficial veins of the arm; 9, Ulnar Artery; 10, Tendon of the Flexor Sublimis; 11, Tendon of the Flexor Carpi Ulnaris; 12, Tendon of the Palmaris Brevis.

Pl. 18.

Fig 2.

Fig 1.

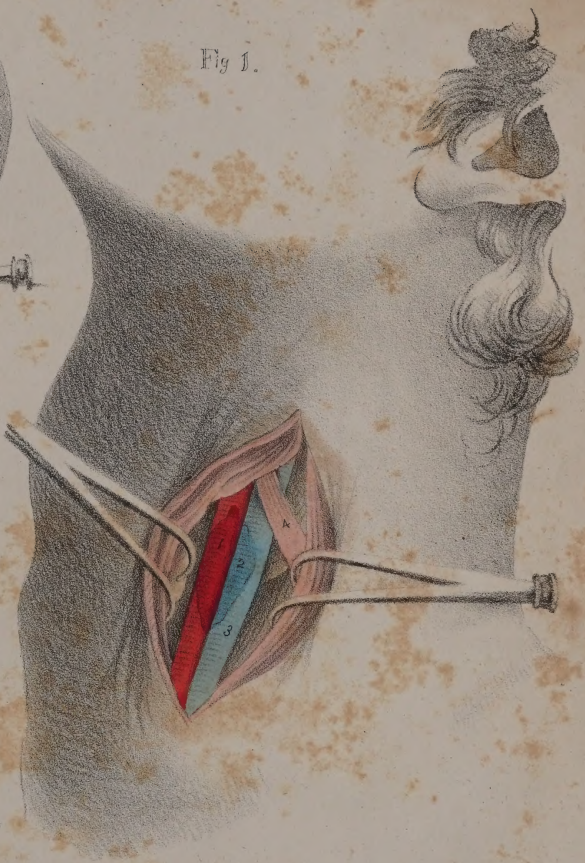


Fig. 2.

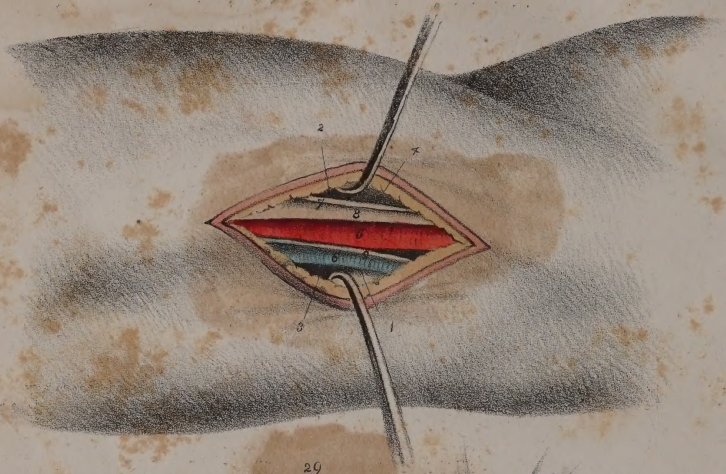
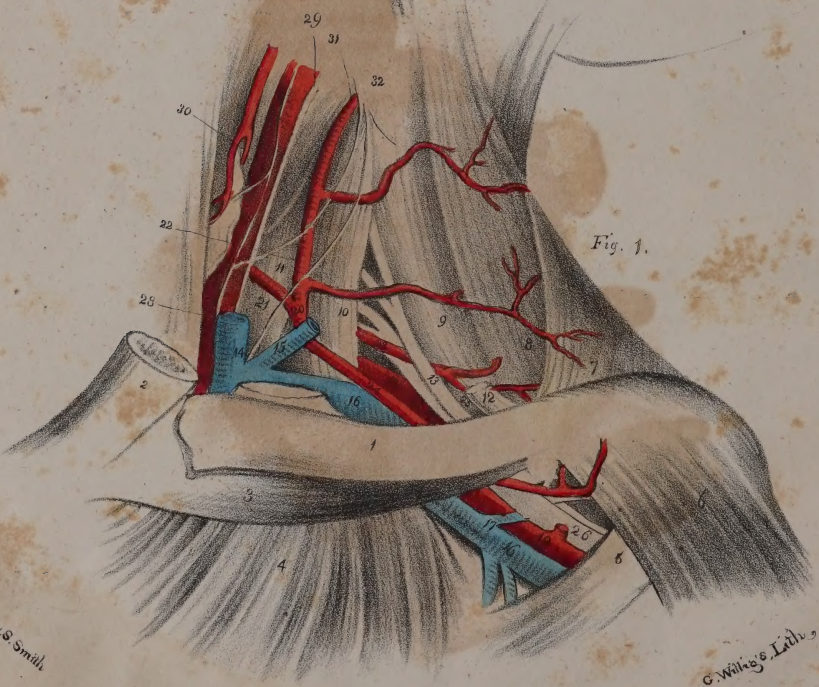


Fig. 1.



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C. Wilkes Lith.

INDEX TO PLATE XIX. Fig. 1. Exhibits the relative anatomy of the lower and lateral region of the Neck as concerned in the operation of cutting for the Subclavian Artery.

No. 1 marks the Clavicle; 2, the sternal origin of the Sterno-mastoid muscle; 3, the Subclavius muscle; 4, Intercostal muscle; 5, Tendon of the Pectoralis Minor; 6, Deltoid muscle; 7, portion of the Trapezius muscle; 8, Levator Scapulæ; 9, posterior Scalene muscles; 10, anterior Scalene muscle; 11, Longus Colli muscle; 12, section of the Omo-hyoid muscle; 13, Brachial Plexus of Nerves; 14, Internal Jugular vein; 15, Cervical vein; 16, 16, Subclavian vein; 17, branch of the Subclavian vein crossing the Subclavian Artery; 18, Subclavian Artery; 19, Thoracico-acromial branch of same; 20, common trunk of the Inferior Thyroid, Deep Ascending Cervical, and Dorsal Artery of the scapula; 21, Inferior Thyroid; 22, Posterior Cervical artery; 23, the Transverse Cervical; 24, 25, Arteria Dorsalis Scapulæ; 26, the Brachial Nerves; 27, the Vertebral Artery; 28, the Nervus Descendens Noni, 29, 30, the Par Vagum.

FIG. 2. Represents the method of cutting for the Brachial Artery in the middle of the arm. Nos. 1, 3, portion of the Triceps muscle; 2, 4, Margin of the Biceps Flexor; 5, Brachial Artery; 6, Brachial Vein; 7, portion of the Musculo-cutaneous nerve; 8, Median nerve; 9, Internal Cutaneous nerve.

INDEX TO PLATE XX. Plate 20 represents the relative anatomy of the parts concerned in cutting for the External Iliac Artery, and the Femoral Artery; also, modes of cutting for the Popliteal, and Anterior Tibial Arteries.

FIG. 1. No. 1 marks the External Oblique muscle of the abdomen; 2, the Psoas muscle issuing beneath Poupart's ligament; 3, the Sartorius muscle; 4, the Rectus Femoris; 5, the Tensor Vaginæ; 6, the Pictinæus; 7, the long head of the Triceps Adductor; 8, Testis and Spermatic Cord; 9, Inferior column of the tendon of the External Oblique; 10, 10, Inguinal Glands; 11, Femoral vein; 12, Femoral Artery; 13, Branch to glands; 14, the Superficial Circumflex Iliac Artery; 15, Saphena Vein; 16, External Pudic Artery; 17, branch of the External Circumflex; 18, branch of the Saphena.

FIG. 2. Exhibits the mode of cutting for the Poplitæal Artery. No. 1, 1, mark the fatty substance in which the vessels are buried; 2, 2, the Poplitæal Artery; 3, that portion of the same vessel to which the thread is to be applied; 4, Poplitæal vein; 5, Poplitæal Nerve.

FIG. 2. Illustrates the operation of cutting for the Anterior Tibial Artery. No. 1, the Fascia of the Leg; 2, the Tibialis Anticus muscle; 3, the extensor Communis Digitorum; 4, the Anterior Tibial Artery; 5, the accompanying Nerve; 6, a Vena Comes.

FIG. 3. Shews the method of cutting for the same artery where it is passing to the dorsum of the foot. No. 1 is the Fascia of the dorsum of the foot; 2, is the tendon of the Extensor Proprius Pollicis; 3, the tendon of the Extensor Communis; 4, the accompanying Nerve; 5, the Arteria Dorsalis Pedis; 6, 7, Venæ Comites; 8, Tendon of the Peroneus Tertius.

Pl. ~~18~~ 20

Fig. 2.

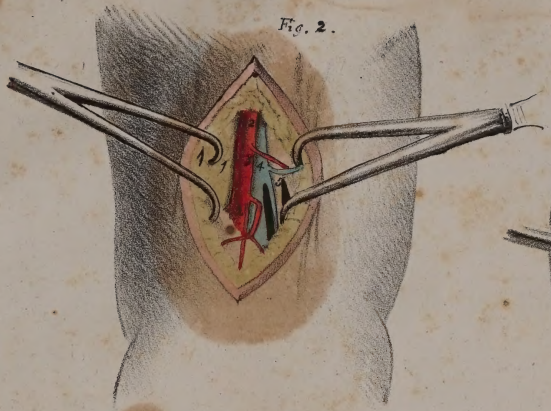

Fig. 3.

Fig. 1.